American Clinical Neurophysiology Society

Technical Standard 1
(ACNS TS1)

Standard for Transferring Digital Neurophysiological Data Between Independent Computer Systems

February 2008

0. History

0.1 This Technical Standard was developed by a subcommittee of the Medical Instrumentation Committee, American Electroencephalographic Society (AEEGS) in 1989-1991. AEEGS was renamed the American Clinical Neurophysiology Society (ACNS) in 1995.

0.2 It was placed under the jurisdiction of the American Society for Testing and Materials (ASTM) Committee E-31 on Computerized Systems and was the direct responsibility of Subcommittee E31.16 on Interchange of Electrophysiologic Waveforms and Signals. The ASTM originally published this Technical Standard as ASTM Standard E 1467-92 in 1992.

0.3 The standard was revised and republished as ASTM E 1467-94. Standard E 1467-94 and related standards were based in part on ASTM Standard E 1238, Specification for Transferring Clinical Observations Between Independent Computer Systems. ASTM Standard E 1238 was also closely related to HL7 [Health Industry Level Seven] version 2.3.

0.4 Partly due to user request for an abridged version of the standard, such a version was published as ASTM Standard E 1713-95.

0.5 In 2001-2, the ASTM devolved significant numbers of standards under their jurisdiction, including those under the jurisdiction of Committee E31. At this time, the ACNS negotiated with ASTM to obtain copyright of E 1467-94, which became ACNS Technical Standard 1 (TS1).

0.6 The former ASTM Standard E 1238 was transferred to the National Committee for Clinical Laboratory Standards (NCCLS) as Laboratory Interchange Standard 5-A (LIS 5-A).

0.7 The binary data formats were added in 2007.

0.8 This Technical Standard is under the jurisdiction of the Medical Instrumentation Committee (MIC) of the American Clinical Neurophysiology Society (ACNS), 1 Regency Dr., P.O. Box 30, Bloomfield, Connecticut 06002.

1. Scope

1.1 This Technical Standard covers transmission of digitally recorded electrophysiologic waveform data and related textual annotations between laboratories or clinics, or between computer systems in a given laboratory or clinic. This includes all electroneurophysiology (EN) studies such as electroencephalograms (EEG) and magnetoencephalograms (MEG), polysomnograms (PSG) and multiple sleep latency tests (MSLT), evoked potentials (EP) and evoked magnetic fields (EMF), event-related potentials (ERP), electromyograms (EMG) and nerve conduction studies (NCS), and many others in either a clinical or research environment. Although this Technical Standard is concerned primarily with electro-neurophysiology, the methods used for encoding waveform and related data would be suitable for other tests involving waveforms, such as electrocardiograms (EKG), vascular/intracranial pressure monitoring, oximetry, or gastrointestinal motility studies.

1.2 This Technical Standard defines a format for waveform data based on NCCLS LIS 5-A, with extensions to support the transmission of multichannel time-series waveforms.

1.3 This Technical Standard may be applied either to two-way transmission of data over medium- to high-speed data communication networks, or one-way transmission of data by recording on and later playback from magnetic or optical digital storage media. It defines the blocked stream of data, called a message, which is transmitted over a network connection or recorded on a storage medium. It does not define the hardware or software network protocols or storage media formats needed for message transmission (for example, see ISO 8072), or the formats used to store data internally by the sender or receiver. For applications requiring binary formatting of waveforms, this Technical Standard defines allowable binary data file formats for waveform data.

1.4 Recognizing, however, that some standardization in storage media format and network protocols would help to promote exchange of data between computer systems with diverse hardware and software, it is suggested that readily available universal media and formats be used, when possible, for data exchange. Examples include digital audio tape (DAT), compact disks (CD-R, CD-RW, DVD-R, etc.), floppy disks written in MS-DOS **(1)**[1] or another commonly used format. The data would be contained within a single sequential file on the disk, with lines within the file delimited by carriage return (ASCII 13) or carriage return followed by linefeed (ASCII 10) characters. An example of network hardware and software suitable for transmission of waveform data would be Ethernet **(2)** and the TCP/IP **(3)** protocol.

1.5 The American Clinical Neurophysiology Society takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

1.6 The major topics can be found in the following sections.

[1] The **boldface** numbers in parentheses refer to the list of references at the end of this Technical Standard.

Section

2. Referenced Documents

2.1 *NCCLS Standard:*
NCCLS LIS 5-A, Standard Specification for Transferring Clinical Observations Between Independent Computer Systems[2] [formerly ANSI/ASTM Specification E1238-97[3]]

2.2 *ANSI Standards*:
X3.4-1986 Coded Character Sets—American National Standard Code for Information Interchange (7-Bit ASCII)[4]
X3.50-1986 Representations for U.S. Customary, SI, and Other Units to be Used in Systems with Limited Character Sets[4]

2.3 *ISO Standards*:
ISO 2022-1986 Information Processing—ISO 7-Bit and 8-Bit Coded Character Sets—Code Extension Techniques[5]
ISO 2955-1983 Information Processing—Representation of SI and Other Units in Systems with Limited Character Sets, 2nd Edition[5]
ISO 4217-1990 Codes for the Representation of Currencies and Funds[5]
ISO 8072-1986 Network Standards[5]
ISO 8859-1988 Information Processing—8-Bit Single-Byte Coded Graphic Character Sets[5]
ISO 10646-1993 Information Technology—Universal Multiple-Octet Coded Character Sets (UCS)— Part I: Architecture and Basic Multilingual Plane[5]

2.4 *Other Standards*:
Health Industry Level 7 Interface Standards[6]

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[2] Available from the National Committee for Clinical Laboratory Standards (NCCLS), 940 W. Valley Rd., Suite 1400, Wayne, Pa. 19087-1898. (There is a planned change of name to the Clinical Laboratory Standards Institute.)

[3] *Annual Book of ASTM Standards,* Vol 14.01.

[4] Available from American National Standards Institute (ANSI), 11 West 42nd St., 13th floor, New York, NY 10036.

[5] Available from International Standards Organization (ISO), 1 Rue de Varembe, Case Postale 56, CH1211, Geneve, Switzerland.

[6] Health Level 7, Mark McDougall, Executive Director, 900 Victors Way, Suite 122, Ann Arbor, MI 48108.

3. Significance and Use

3.1 *General Approach:*

3.1.1 This Technical Standard defines a general and flexible mechanism for the formatting and transmission of digitized waveforms in order to facilitate portable exchange between dissimilar computer systems. This mechanism can serve for many different types of physiological signals. This Technical Standard also defines how associated identifying and other annotative textual data can be incorporated into the data stream. Such information in digital form provides the complete context necessary for interpretation of a test or study performed for clinical diagnosis or for basic or clinical research purposes.

3.1.2 Both primary and derived data comprising an electrophysiologic study may be transmitted using this Technical Standard. Primary data includes digitized waveforms for multiple channels; channel identifications, sensitivities, filter settings, and sampling frequency; averaging parameters (for averaged data); date and time-of-day labels; electrode or transducer locations and attributes; measured distances; stimulation parameters (when visual, auditory, electrical, or other stimulation is performed); calibration data; technical comments or annotations created before or during the study; medications administered; special procedures performed; and instrument(s) used. This primary data represents everything that would be traditionally written on paper along with the waveforms at the time the study was performed.

3.1.3 Derived data includes measured feature or peak latencies, amplitudes, and other characteristics (which may be detected and generated by automatic algorithms or by a technician or physician scan of the data), or results of computer processing of the primary data (for example, spectral analyses). It also includes the quantitative or qualitative results which are reported to the ordering physician and which may be compared with the laboratory's normal ranges for these quantities, and text reports, interpretations, diagnoses, and recommendations which are sent back to the ordering physician.

3.1.4 This Technical Standard further defines how the general mechanisms for formatting and transmitting these data are to be applied specifically for electroneurophysiologic study data. Applications for EKG and other electrophysiologic studies can be developed using the same general mechanisms.

3.2 *Levels of Implementation*:

3.2.1 In order to facilitate the use of this Technical Standard over a wide range of applications, various levels of implementation are defined. Three levels are defined, according to the scope and nature of data to be transmitted, as follows:

3.2.1.1 *Level I - Waveforms Only*—This most basic level of implementation specifies the mechanism for transmission of digitized, multichannel, time-series waveforms. A Level I transmission includes the information required for proper decoding of the digital waveform data and labeling of channels. It further includes an *envelope*, formatted in accordance with the NCCLS LIS 5-A standard message structure, which provides the information required by a deformatting program in a system receiving the transmission. A Level I implementation of a receiving system would only need to recognize those types of data defined as required in Level I, but it must be designed to accept, without generating an error condition, any additional data included in a transmission produced by a higher level system; the additional information which is irrelevant to the Level I receiving system may be ignored or merely logged without interpretation.

3.2.1.2 *Level II - Waveforms or Procedure Annotations, or Both*—This level may include waveform data, but in addition it specifies the mechanism for embedding in the data transmission various identifying, annotative, and interpretive information associated with the study. This information constitutes a digital representation of the entire study. Level II defines the required data elements and their format, as well as optional data elements (with provision for site-specific data). Much of the data consists of free format text, such as labels and annotations which may be displayed on a screen (usually in association with the waveforms) or printed on a report form. A Level II implementation need not necessarily handle actual digital waveform data; it may, for example, deal only with the final interpretive report for transmission between computers comprising a hospital information system. All Level II receiving systems must, nevertheless, be designed to accept digital waveform data incorporated in a Level I, II, or III transmission without generating an error condition, even if the waveform information is merely ignored.

3.2.1.3 *Level III - Coded Information*—Level III has the same scope of data as Level II but, in addition, associates standard alphanumeric codes with several of the textual data elements. For example, in Level II implementations, a diagnostic impression which applied to a particular study or portion thereof would be transmitted as a text string of arbitrary contents; in Level III implementations, it could alternatively be transmitted as an alphanumeric code such as an ICD-9-CM code **(4)** which the receiving system would translate into a defined text string by means of an internal table of diagnoses. The intent is to create a more structured and standardized medical record and thereby facilitate automated machine processing. For example, codification of the possible responses in a data field would allow a receiving system to make decisions regarding printing or display, automatic routing, etc., more easily based on the information contained in the transmission. Furthermore, the use of alphanumerically coded data would increase the uniformity of the medical record within an institution or laboratory and among different institutions, and misinterpretation or misapplication of information would not be as likely as with free text.

3.2.2 This version of the Technical Standard introduces a system of universal codes (based on CPT-4 **(5)**) for classifying the standard electrophysiologic studies, for grading quantitative or classifying qualitative test results, for specifying anatomic localizations, and for specifying diagnostic impressions for electrophysiologic tests (see Appendix B). These codes should be used whenever appropriate by Level I and II implementations, in association with a text description, but only Level III implementations would be required to include a code table and thus be able to translate the alphanumeric code into a text description (or vice versa) when needed. Instead of, or in addition to, using these universal codes, an institution or laboratory may use a locally defined coding system, if available. The format defined by this Technical Standard for those data items which may be coded is flexible enough that a transmitting system may always elect to send either an alphanumeric code or a text string, or both. If both were transmitted, for example, a receiving system of any implementation level could simply display the textual data as received, possibly ignoring the alphanumeric code; only a Level III receiving system would be required to maintain code tables and could therefore generate the text string automatically if only an alphanumeric code were sent.

3.3 *Direction of Information Exchange*—Some systems will be producers of information (also referred to as acquisition systems, transmitters or senders, formatters), while some will be consumers of information (display systems, receivers, deformatters). A given system may be both a producer and a consumer; an example is a digital machine that had the capability to transmit the waveform data which it acquired to another computer for signal processing, specialized display, archiving, or reporting, as well as the capability to receive data from another device for viewing on its display screen or printing on a hardcopy device.

3.4 *Types of Communication Supported*—A further delineation of complexity of implementation concerns two-way communication between systems. In a fully integrated hospital information system, for example, a laboratory computer may receive from another computer system an order to perform a test or a request for data; it might be expected to respond to such an event, and this Technical Standard defines the mechanisms to implement this capability. On the other hand, a particular instrument may only be able to output the data it acquires, without any facility for interaction with the receiving system.

3.5 *Description of Implementation*—A full description of a given implementation of this Technical Standard in a laboratory instrument or software system will require designation of level (Level I, II, or III), type of data handled (waveforms or annotations, or both), direction of exchange (transmitter or receiver), and communications capability (one-way or two-way message interface) as well as the type(s) of networks or storage media, or both, supported for data transmission or reception. Furthermore, coding schemes for Level III implementations must be specified or described. In addition, the limitations of the system (for example, minimum and maximum sampling frequencies for digital waveform data, maximum numbers of channels and montages, allowed transmission data formats, etc.) must be specified.

4. Message General Content Considerations

4.1 *Relation to NCCLS LIS 5-A*:

4.1.1 This Technical Standard is primarily based on NCCLS LIS 5-A. All requirements of NCCLS LIS 5-A must be adhered to by implementations of *this* Technical Standard, except where specifically noted herein. NCCLS LIS 5-A defines some features (such as data types, information categories, and code tables) which are not mentioned in this Technical Standard.

4.1.2 [Deleted]

4.1.3 [Deleted]

4.1.4 This Technical Standard, like NCCLS LIS 5-A, defines both the logical content of a data interchange and the encoding rules for representing that content in a particular message. *Logical content* means the specification of the data elements (fields), their logical representation (for example, a date is recorded as **YYYYMMDD**), their aggregation into segments, and the aggregation of segments into messages. *Encoding rules* means the rules that now specify that messages be represented as ASCII characters, that fields be identified by their position in a segment, and that delimiters separate the data elements within segments. The distinction between logical content and encoding rules is important because the two should be independent. With the exception of the data and segment types, Section 4 deals mostly with encoding rule issues; subsequent sections deal mostly with logical content.

4.2 *Extensions to NCCLS LIS 5-A Standard Formats*—This Technical Standard defines several minor extensions to that standard, as described as follows. The use of these extensions in data transmissions is optional; a transmitting system which implements this Technical Standard may choose to send data in a format which is entirely compatible with NCCLS LIS 5-A, but a receiver system must be able to accept transmissions that use these extensions when appropriate, in order to be considered compatible with this Technical Standard.

4.2.1 *Specifying Information Categories in OBR and Q Segments*—This Technical Standard extends the order (OBR) segment test/observation identification (ID) field to allow specification of an optional information category code after the test/observation ID (separated by a subcomponent delimiter) when it is desired to restrict the types of result segments which will be returned in response to the order request in a two-way message transmission system; this would also apply to the NCCLS LIS 5-A request results (Q) segment test/observation ID field. Although this capability is currently not explicitly stated in NCCLS LIS 5-A, it is consistent with the usage of information category codes in test/observation IDs in result (OBX) segments.

4.2.2 *Specific Code Table Identifiers in Coded Entries*—This Technical Standard extends the NCCLS LIS 5-A standard coded entry (CE) format to allow specification of an optional specific code table identifier as a second subcomponent of the third or sixth components (following the coding system mnemonic identifier). The NCCLS LIS 5-A standard explicitly allows a second subcomponent in these components only when the coding system mnemonic indicates local codes (**99zzz**, where each *z* represents an alphanumeric character, or **L**), but it is also useful to be able to delineate specific code tables for other coding systems (for example, to distinguish SNOMED **(6)** diagnostic codes from SNOMED topographic codes).

4.2.3 *Maximum Field Lengths in OBX Segments*—This Technical Standard increases the maximum length of several OBX segment fields to accommodate the needs of electrophysiologic data transmissions. The maximum length of the OBX segment test/observation ID field is increased from 80 to 590 characters, to allow for the long text descriptions of tests, portions of tests, and individual test results which may be needed for electrophysiology. The maximum length of the OBX segment units field is also increased from 20 to 590 characters, to allow for longer units of measure in the coded entry (CE) data format. In addition, this Technical Standard allows an alternative format for the reference range in the OBX segment that may be used when there is only one bound, not two.

4.2.4 *Message Acknowledgment (MSA) Segment*—This Technical Standard defines an additional segment type MSA (message acknowledgment), which may be used in messages sent in reply to another message (in systems that implement two-way communication) to identify the original message, specify whether the original message was successfully processed or whether an error was detected, and (in messages responding to a system characteristics query request) to return the system characteristics or capabilities (the response to the query). This segment closely follows the format of the HL7 MSA segment; however, the last two fields of the HL7 MSA segment are not used in this Technical Standard because they are not relevant to NCCLS LIS 5-A formatted messages.

4.2.5 *Subject Filter and Qualifiers Field in Q*

Segments—This Technical Standard uses requestor special field 2 in the request result (Q) segment as a subject filter and qualifiers field. Its data type is changed from ST (string) to CM (composite miscellaneous) so that it may contain more than one component. The field is used to extend the usage of the Q segment to encompass a variety of queries other than requests for results. The first component of this field is similar to the *What Subject Filter* field in the HL7 Query Definition (QRD) segment, while subsequent components further qualify the subject of the query. This field was set aside by NCCLS LIS 5-A for arbitrary use by the requesting (querying) system.

4.3 *Message Characteristics and Terminology*—The NCCLS LIS 5-A encoding rules define a format for message transmission which is compatible with a wide variety of computers, operating systems, and communications media.

4.3.1 *Characters*—In order to promote interchange of data among systems using the largest possible variety of architectures, operating systems, networks, and storage media, all data in the message should be limited to a restricted set of ASCII characters as defined in ANSI X3.4-1986; specifically, these include ASCII 32 through 126 (space, lower and upper case letters, digits, and special printing characters), 7 (BEL, bell), 9 (HT, tab), 10 (LF, linefeed), 11 (VT, vertical tab), and 12 (FF, formfeed), with ASCII 13 (CR, carriage return) reserved for use as a line terminator. However, any unprintable characters (ASCII 0 to 31 or 127) immediately following a carriage return and up to the next printable character (ASCII 32 through 126) will be ignored by the receiver. Thus, for example, either carriage return or carriage return followed by linefeed can be used as an end of line sequence. The restriction to the limited subset of 7-bit ASCII characters is necessary since some existing operating systems and media or networks can only send and receive these characters, while others may make use of the high-order bit of each 8-bit byte or of the non-printable control characters to control message flow or for parity and similar data integrity checks.

4.3.1.1 It is recognized that, in certain contexts, a full 8-bit character set may be necessary or useful. For example, the international community has need of printable characters such as é or ü, which are not within the restricted character set defined in 4.3.1 (such a character may be included in text data by use of the \Dnnn\ escape sequence defined in 4.4.15, where *nnn* is the three-digit decimal code for the desired character, but this method requires six bytes to transmit a single character). ISO 8859 defines one 256-character (8-bit) set that does include all of the needed letters for the European Latin-alphabet languages, and at this time it would be the recommended character set for implementations of this Technical Standard in countries which use European languages and need to conveniently and compactly represent characters other than those defined in ANSI X3.4-1986. The restriction on character set in 4.3.1 may therefore be ignored (that is, arbitrary 8-bit characters may be transmitted) if the transmitting and receiving systems and the communications media used are known to support the full set of character codes, but the transmitting system then runs a risk of not being able to send its data to an alternate receiving system or by means of alternate communications media or networks. The use of characters other than the restricted set defined in 4.3.1 is thus to be considered non-portable and nonstandard, and should be used primarily for internal communications within a particular system or institution. A receiving system which is compatible with this Technical Standard need not be designed to accept characters other than from the restricted set.

4.3.1.2 For many languages (such as Japanese or Chinese), even 8-bit character codes are not sufficient to represent all of the characters that may be needed, especially in text data, such as comments and reports. Two possible ways to transmit characters represented by more than eight bits are *(1)* to use a fixed number (two or more) bytes to transmit each character in the message (including delimiter characters and line terminator characters), or *(2)* to mix single-byte and multi-byte characters in the same message by using special escape sequences to switch from single-byte mode to multi-byte mode and from multi-byte mode to single-byte mode. An example of the former method is the UNICODE character set **(7)** or the ISO 10646 standard. An example of the latter method is the ISO 2022 standard (which has been adopted in Japan as JIS X 0202 in order to mix Kanji and ASCII characters). Either of these methods could be used in implementations of this Technical Standard in countries that need to conveniently and compactly represent characters requiring more than eight bits, but until a single such character set achieves the status of a universal world standard, interchange of data using such multi-byte character sets can take place only within particular systems or institutions that agree to communicate in this fashion. When escape sequences are used to switch between different character byte lengths, the multi-byte characters and their surrounding escape sequences should be confined to specific data items (most commonly text fields) in the message; the delimiter characters that separate these data items should be the usual single-byte (preferably 7-bit ASCII) characters.

4.3.1.3 In this Technical Standard, *alphabetic* characters refer to lower and upper case letters; *numeric* characters refer to the digits 0 to 9 and the decimal point (.); and *alphanumeric* characters refer to lower and upper case letters, digits, period (.), hyphen (-), slash (/), plus (+), asterisk (*), percent (%), parentheses (()), and underscore (_); the last nine are *alphabet extenders* that may be used in codes or names to increase readability, or for special purposes.

4.3.2 *Segments*—The message consists of a sequential series of segments, each of which conveys one aspect of the message. Each segment is of a particular type. For example, there are header segments, order (OBR) segments, result (OBX) segments, etc. Paragraph 4.5 lists the allowed types of segments in a NCCLS LIS 5-A message. A segment is transmitted as a single line ending in a carriage return character or, when necessary, as multiple lines (the first line beginning the segment, and the subsequent *addenda* lines continuing it, as described in 4.3.7).

4.3.3 *Fields*—A segment consists of one or more fields, separated from each other by field delimiter characters. Each field defines one attribute of the segment. A field may itself contain aggregates of data elements in a hierarchical fashion, each separated from the others by an appropriate delimiter character. Specifically, a field may consist of more than one subfield separated by repeat delimiters; a subfield may consist of one or more components separated by component delimiters; and a component may consist of one or more subcomponents separated by subcomponent delimiters. Each of these data elements has a defined data type (text, numeric, coded entry, etc.), as described in 4.4.

4.3.4 *Delimiters*—Within data elements (fields, subfields, components, and subcomponents), only printable ASCII characters (32 through 126) are permitted, and field, repeat, component, and subcomponent delimiters and the escape character (except when beginning or ending an escape sequence in text data) must be excluded. The sender is responsible for screening all data elements to ensure that they do not contain those delimiters. The recommended delimiters are: field delimiter | (vertical bar); repeat delimiter ~ (tilde); component delimiter ^ (carat); subcomponent delimiter **&** (ampersand); and escape character \ (backslash). Although other printable (@, #, $) and special (bell, tab, vertical tab, formfeed, linefeed) characters *may* be used for delimiters (since the five delimiter characters are specified in the message header segment at the start of the transmission), these characters are used in the examples in this Technical Standard. The alphanumeric characters defined in 4.3.1.3, spaces (blanks), punctuation marks (!;:'`",.?), braces and brackets ([{}]), and the less than (<), equal (=), and greater than (>) characters should not be used as delimiters because they are likely to appear within data elements.

4.3.5 *Case Sensitivity*—Keywords and code names defined in this Technical Standard are *case insensitive* (their meaning is unchanged whether transmitted in upper or lower case). The case of free-format text, including user-defined electrode, channel, and analysis parameter names, is preserved during transmission; a receiver may or may not treat instances of user-defined names with differing case (for example, FP1 and fp1) as the same name.

4.3.6 *Field Lengths*—All fields are variable in length. Fields are terminated by a field delimiter (or by a carriage return if the following line is not an addendum line). This Technical Standard defines a maximum length for each field, component, or subcomponent. A transmission *may* include fields, components, or subcomponents which exceed these maximum lengths (due to transmitter software design or error, or due to a transmission error such as a lost delimiter), and all receiving systems which adhere to this Technical Standard must accept the extra characters without generating a fatal error. However, a receiver may ignore any characters in a field, component, or subcomponent beyond the maximum length; alternatively, to allow more flexibility and to provide for increases in the maximum lengths that may be incorporated into future versions of this Technical Standard, receiving systems *may* be designed to process more characters than the currently specified maxima.

4.3.7 *Maximum Line Length*—NCCLS LIS 5-A allows a maximum line length of 220 characters, including the terminating carriage return. Segments longer than 220 characters must be transmitted as multiple lines, using an addendum marker in the first two character positions of lines after the first to indicate logical continuation of a field, component, or subcomponent into the next line. That is, any segment which would exceed the 220 character maximum line length must be split by inserting a carriage return, an **A** character, and a field delimiter (|) in the character stream at appropriate intervals (the break may occur at any point, even in the middle of a field, subfield, component, or subcomponent). This provision is necessary because of the maximum line lengths allowed by some communications networks, media, file systems, and operating systems. This restriction on line length may be ignored (that is, lines longer than 220 characters may be transmitted) if the transmitting and receiving systems and the communications media used are known to support longer lines, but the transmitting system then runs a risk of not being able to send its data to an alternate receiving system or by means of alternate communications media or networks. The use of lines longer than 220 characters within an NCCLS LIS 5-A message is thus to be considered non-portable and nonstandard, and should be used primarily for internal communications within a particular system or institution. A receiving system which is compatible with this Technical Standard need not be designed to accept lines longer than 220 characters.

4.3.8 *Not Present and Null Values*—All fields, components, and subcomponents are positional. Values which are not present (omitted if they are the last field, or else specified as two adjacent delimiters) are usually interpreted by the receiving system as an instruction to use some default or previously transmitted value for that field, component, or subcomponent. If it is desired to set a field, component, or subcomponent explicitly to a null string, two adjacent double quotes "" (ASCII 34, 34) may be used to override any default or preexisting values for the field, component, or subcomponent. If a receiving system cannot deal with a data item which is not present, it may treat it as present but null.

4.3.9 *Units of Measure*—The standard representations of units of measure are either the SI unit abbreviations defined by ISO 2955-1983 or the U.S. customary unit abbreviations defined by ANSI X3.50-1986, supplemented by additional units used for clinical care given in NCCLS LIS 5-A, Tables 26 (ANSI) and 25 (ISO). This Technical Standard also defines two special units for electrophysiology *(pha* = number of phases and *tur* = number of turns in a waveform) which may be used as if they were part of the ISO units. The two systems of units are identified by coding system mnemonic identifiers **ISO+** and **ANS+**, respectively, in coded entry fields (see 4.4.2). It is necessary to specify which system is used, since some abbreviations have different meanings in each system (for example, ft = femptotesla in **ISO+**, but ft = foot in **ANS+**); the default is **ISO+**. Only single case abbreviations are used since all names are case insensitive in this Technical Standard. New units may be created by prefixing a multiplier to a basic unit (for example, μV = micro+volts). Derived units can also be created by raising a basic unit to an exponential power by appending the exponent (with leading 0. if fractional) to the unit (for example, uv2 = μV^2 = microvolts squared, hz-1 = Hz^{-1} = 1/hertz, hz0.5 = $Hz^{1/2}$ = square root of hertz). Derived units can also be created by multiplying or dividing two basic units. This is signified by a period (.) or a slash (/) between units (for example, mv.s = millivolts times seconds, m/s = metres per second). These options may be combined when necessary; for example, uv2/hz = microvolts squared per hertz (unit of spectral power), uv/hz0.5 = microvolts per square root of hertz (unit of spectral amplitude). Exponentiation has precedence over multiplication or division.

4.4 *Data Types*—The following briefly describes most of the data types which may be used in fields, components, and subcomponents of segments, along with their two character mnemonics. Refer to NCCLS LIS 5-A for detailed information about the use and format of all of these data types.

4.4.1 *Address Data (AD)*—This composite data type is used to represent postal addresses. An AD type field consists of six components, separated by component delimiters (^). The first component is the street address or post office box number. The second component is the apartment number or other internal address. The third component is the city. The fourth component is the state or province. The fifth component is the zip or postal code. The sixth (optional) component is the country name.

4.4.2 *Coded Entry Data (CE)*—This composite data type is used to represent most of the computer-interpretable variable data items within a segment. This Technical Standard, along with the NCCLS LIS 5-A and HL7 standards, encourages the transmission of diagnostic impressions, anatomic localizations, qualitative test results or findings, and similar items as coded data, and it requires that test/observation identifiers be transmitted as coded data. By providing both an alphanumeric code and the identity of the coding system and code table, the CE data type decouples the definition of the message structure (syntax) from the actual diagnostic/anatomic/observation codes (semantics), and allows flexible choice of a coding system and the use of multiple coding systems for different purposes. Finally, the CE data type permits a transmitting system to send a data item using locally defined codes in addition to or instead of universal (national or international) codes, provided that the locally defined codes are known to the receiving system. A coded entry (CE) field contains up to six optional components, organized as two triplets. Each triplet specifies a code and a coding system, so the complete coded entry field can specify two completely separate codes and coding systems for the same data item. The format is as follows:

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<Code 1>^<Text or description of Code
1>^<Nature of Code 1>^
<Code 2>^<Text or description of Code
2>^<Nature of Code 2>
```

In most cases, only the first three components are used, and often the third component is not present because the default applies. The components of a CE format field are as follows:

4.4.2.1 *Code 1*—This component contains an alphanumeric code that identifies the data item, taken from a generally accepted coding system; in certain cases (specifically, for test/observation IDs), this code may consist of an alphanumeric portion, followed by a subcomponent delimiter **(&)** and an alphabetic information category code. It is possible for this alphanumeric code in a CE format field to be not present, so that the data item being transmitted is defined by a text description only, but this practice is discouraged.

4.4.2.2 *Text for Code 1*—This component contains a text description of the data item identified by Code 1. It may be used to provide an annotated description of the alphanumeric code for Level I or II receiving systems that do not implement code tables and are, therefore, unable to supply a text description from the code alone. Also, it can be used to identify and describe an item that the sender cannot represent with an alphanumeric code from any available coding system, or to provide added specificity or detail to the specified alphanumeric code, but, in this case, manual intervention by the receiving system may be needed to determine the exact nature of the data item. In a Level III implementation of this Technical Standard, tables of text descriptions of each code in the available coding systems are part of the receiving system so that an alphanumeric code sent alone can be expanded to a full text description; such tables are not implemented in lower levels.

4.4.2.3 *Nature of Code 1*—This component identifies the coding system used for Code 1. It consists of a coding system mnemonic identifier (alphanumeric) and an optional specific code table identifier (alphanumeric) separated from the coding system identifier by a subcomponent delimiter **(&)**. Examples of available coding system mnemonic identifiers and corresponding specific code table identifiers are given in Table 4-1; refer to NCCLS LIS 5-A for a complete list. The default coding system and code table depend on the nature of the CE format field. For diagnostic impressions, the default is **I9C**. For anatomic localizations, the default is **SNM+&TOPO**. For test/observation IDs, the default is **AS4&TEST**. For units of measure, the default is **ISO+**.

4.4.2.4 *Code 2*—This component contains any secondary alphanumeric code used to identify the data item. The format is the same as Code 1.

4.4.2.5 *Text for Code 2*—This component contains a text description of the data item identified by Code 2. The format is the same as Text for Code 1.

4.4.2.6 *Nature of Code 2*—This component identifies the coding system used for Code 2. The format is the same as Nature of Code 1, but the default coding system is **L**.

4.4.3 *Composite ID with Check Digit Data (CK)*—This composite data type is used to represent patient identifiers. A CK type field consists of three subcomponents separated by subcomponent delimiters **(&)**. The first (required) subcomponent is an ID number, which should not include special characters such as hyphens. The second (optional) subcomponent is a check digit (a single digit used to verify the validity of the ID number). The third (optional) subcomponent is a code which identifies the algorithm used to calculate the check digit; the default is **M10** (mod 10), but alternatives such as **M11** (mod 11) can be employed. See NCCLS LIS 5-A for information on how to calculate a mod 10 check digit. The use of check digits for patient identifiers is encouraged but not required.

4.4.4 *Composite Miscellaneous Data (CM)*—This composite data type applies to entire fields of segments, and consists of data of arbitrary length, with a defined format, using repeat, component, and subcomponent delimiters to separate individual items within the field. It is used in segments that transmit miscellaneous non-narrative type data (for example, the digitized waveform data). Each component/subcomponent within a CM field has its own data type.

4.4.5 *Composite ID and Name Data (CNA)*—This composite data type is used to represent the ID code and name of a caregiver (for example, physician). A CNA type field consists of three optional components separated by component delimiters (^). The first component is the alphanumeric caregiver ID code, using the coding system specified in the third component. The second component is the caregiver name; it consists of six optional subcomponents separated by subcomponent delimiters **(&)**, as follows: last name; first name; middle name or initial; name suffix (for example, Jr., or III); prefix or title (for example, Dr., Mr., Ms); and degree (for example, MD, PhD, DDS). The third component identifies the coding system used in the first component. Allowed values include **UPIN** (Unique Physician Identification No., the universal physician codes **(8)** of the Centers for Medicare and Medicaid Services (CMS), the default) or **99zzz** or **L** (locally defined codes, where each *z* represents an alphanumeric character). In a CNA format field either a code or a name, or both, may be included.

4.4.6 *Composite Quantity and Units Data (CQ)*—This composite data type is used to represent numeric quantities and their units. A CQ type field consists of two components separated by component delimiters (^). The first component is a numeric quantity. The second (optional) component specifies the units of measurement of the quantity, and consists of six optional subcomponents separated by subcomponent delimiters **(&)**, in a format similar to the CE data type. The first and fourth subcomponents contain standard abbreviations for the units of measure using a standard coding system; the second and fifth subcomponents contain corresponding text descriptions of the units; and the third and sixth subcomponents contain an identification of the coding system used in the first (the default is **ISO+**, but **ANS+** is an alternative) and fourth (the default is **L**, local codes) subcomponents. The coding system mnemonic identifier **ISO+** indicates standard single case abbreviations of SI units (ISO 2955-1983), while **ANS+** indicates standard single case abbreviations of U.S. customary units (ANSI X3.50-1986) not included in the ISO set; derived units may also be used. Many type CQ fields have a default unit defined, which is assumed if the entire second component is omitted.

4.4.7 *Identification String Data (ID)*—This data type is used to represent items for which one choice applies out of a number of defined options. The particular choice is represented by an alphanumeric keyword, and the available choices are usually defined in the relevant sections of this Technical Standard. In some cases, a transmitting system may send a keyword *not* included among the available options, if this keyword is known to have some meaning to the receiving system. This allows for *ad hoc* extensions to this Technical Standard; note, however, that future versions of this Technical Standard may add new keywords that may preempt the nonstandard meanings attached to the same keywords by existing applications.

4.4.8 *Money Data (MO)*—This composite data type is used to represent monetary quantities and the currency of measure. An MO type field consists of two components separated by component delimiters (^). The first component is a numeric quantity that specifies the money amount. The second (optional) component specifies the currency of measure, using the short ISO codes for currency (ISO 4217-1990). If omitted, the default currency is dollars (**USD**) in the United States; other defaults may be assumed by local agreement.

4.4.9 *Numeric Data (NM)*—This data type is used to represent quantitative items, which may consist of digits (0-9), an optional decimal point (.), and an optional preceding plus (+) or minus (-) sign. Scientific notation (mantissa and exponent) is not allowed.

4.4.10 *Person Name Data (PN)*—This composite data type is used to represent a person's name, such as a patient name. A field of type PN consists of six optional components separated by component delimiters (^). The first component is the last name. The second component is the first name. The third component is the middle name or initial. The fourth component is the name suffix (for example, Jr., or III). The fifth component is a prefix or title (for example, Dr., Mr., Ms). The sixth component is a degree (for example, PhD, DDS, MD).

4.4.11 *Reference Pointer Data (RP)*—This composite data type encodes information about data stored on another system. It contains a reference pointer that uniquely identifies the data on the other system, the identity of the other system, and the type of data. For applications involving storage of a message on a storage medium as opposed to transmission over a network connection, the reference pointer merely identifies the data on a local storage medium. An RP type field consists of three components separated by component delimiters (^), as follows:

```
<pointer>^<application-ID>^<type-of-data>
```

4.4.11.1 *Pointer*—This component is a unique key assigned by the system that stores the data. The key, which is an ST data type, is used to identify and access the data. This key consists of an optional device name **dddd** followed by a colon (:), followed by an optional file specification **ffff** (including path or directory information if necessary) followed by a colon (:), followed by a byte address **aaaa** within the file, followed by a colon (:), followed by a byte length **llll**. Colons rather than subcomponent delimiters are used to separate the subcomponents of the pointer for compatibility with HL7, since in HL7's RP data type definition, the pointer does not contain any subcomponents. If the device name or file specification is omitted, the colon delimiters are still required. The following variations are allowed:

dddd:ffff:aaaa:llll *(device and file specification both*

	present)
:ffff:aaaa:llll	*(only file specification present)*
dddd::aaaa:llll	*(only device specification present)*
::aaaa:llll	*(neither device nor file specification present)*

The device name **dddd** may contain up to 80 characters. If omitted in the first RP field in the message, a default device is assumed by the system on which the file is stored. If omitted in subsequent RP fields in the message, the device is assumed to be the same as that in the last RP field containing a device name. The file specification **ffff** may contain up to 255 characters and consists of zero or more directory names preceding a file name, each directory name being separated from the others by slash (/) characters, to form a complete path specification, for example:

filename *or*
/directory/filename *or*
/dirlevel0/dirlevel1/dirlevel2/.../filename

If omitted in the first RP field in the message, a default path or directory and filename is assumed by the system on which the file is stored. If omitted in subsequent RP fields in the message, the file specification is assumed to be the same as that in the last RP field containing a file specification. The default device name, path (directory) name, and file name used would depend on context. In particular, if the NCCLS LIS 5-A message itself is contained in a file in a particular directory on a disk on a system identified by *application ID*, then when the device name, path, and filename are all omitted, the data pointed to by the RP pointer could be assumed to be located in the same directory on the same disk on that system, with a filename derived from the name of the file containing the message using a simple manipulation (such as changing the file extension to *.dat* to identify a binary data file). However, when the context does not allow an appropriate default to be determined, the pointer must uniquely identify the binary data file on the system identified by *application ID*.

Allowable characters in a device, file, or directory name include letters (upper or lower case, with lower case preferred), numbers (0 to 9), or the special characters underscore (_), period (.), or hyphen (-). However, the first character of a device or directory or file name should be a letter (a-z, A-Z). Because some operating systems or file systems use a single period in a file name for the special purpose of indicating a file extension, device and directory names should not include periods, and a file name should not include more than one period. Because some operating systems or file systems use case-sensitive file names (while others do not), the case of letters in device, directory, or file names should be preserved when the pointer is constructed.

The byte address **aaaa** is a numeric field in the form of an unsigned decimal number of up to 20 digits. This represents the byte offset, i.e. the relative address within the file of the first byte of the block of data pointed to by the RP data field, the first byte in the file being byte 0. The maximum value is 2^{64}-1. The byte length **llll** is a numeric field in the form of an unsigned decimal number of up to 10 digits. This represents the total number of bytes in the block of data pointed to by the RP data field, and should be a multiple of the word length (in bytes) implied by the "subtype" subcomponent of the "type of data" component. The minimum value is 1 and maximum value is 2^{32}-1 (4,294,967,295) bytes.

When constructing a pointer, the actual file specification used by the operating system and I/O system must be translated to the above format by the transmitting system. The receiving system must similarly translate the pointer to the format required by its operating system and I/O system if the file resides on a storage medium local to the receiving system. However, in the case of a file stored on a system other than the receiving system, as indicated by *application ID*, the receiving system must translate the pointer to the format required by the system indicated by *application ID* (which in many implementations will actually be the original transmitting system, which sends a pointer to data located on itself). Because of the differences in file naming conventions among various operating systems and I/O systems, to promote maximum portability and interoperability it is suggested (but not required) that the filename used be limited to 8 alphabetic or numeric characters (with the first character alphabetic), optionally followed by a period (.) and a three character (alphabetic or numeric) file extension.

Some examples of pointers:
a:/eegdir/data/p12345.dat:543278:2048
:waveform:9235148:12800

4.4.11.2 *Application ID*—This component is a unique designator of the system on which the data is stored. If omitted, an implementation-specific default value is assumed. For example, it may be omitted when the message is contained in a file known to the receiving system, in which case the data pointed to by the RP pointer would be assumed to be on the same system as the message file. The application ID is a CM data type which consists of three subcomponents separated by subcomponent delimiters (**&**), as follows:

```
<application identifier> & <Universal ID>
& <Universal ID type>
```

Application ID's must be unique within a given implementation. The first subcomponent (application identifier) is the usual name of the system on which the data is stored, such as a network node name (up to 16 alphabetic or numeric characters). The second (optional) subcomponent (universal ID) is a string which further identifies the system on which the data is stored, in a format determined by the third subcomponent. The third subcomponent (universal ID type) is a code which identifies the nature of the second subcomponent; it may be **L**, indicating a locally-defined coding scheme for IDs, or **DNS**, indicating an internet dotted name (either in ASCII or as integers).

Some examples of application IDs:

node12
eegnod&eegnod.xyz.org&DNS

4.4.11.3 *Type of data*—This component is a code which represents the type of data being stored. This component is a CM data type which consists of two subcomponents separated by subcomponent delimiters (**&**), as follows:

```
<main type> & <subtype>
```

4.4.11.3.1 *Main type*—This subcomponent is an ID data type that declares the general type of data. The standard main types are given in Table 4-2.

4.4.11.3.2 *Subtype*—This subcomponent is an ID data type declaring the format for the data of the first subcomponent. Possible subtypes are specific to main types (though in principle the same subtype could be used for more than one main type). The standard subtypes for each main type are given in Table 4-2. The last two subtypes are extensions defined by this Technical Standard for the transmission of binary waveform data.

The **Octet-Stream** subtype is for binary data which has none of the other standard formats. The interpretation by the system utilizing the data must be mutually agreed upon by sending and receiving parties. Other types may be added to future revisions of this Technical Standard as needed. In addition, private, nonstandard (non-portable) subtypes may be defined by agreement between cooperating parties. All private, nonstandard subtypes should begin with the letter **Z** to distinguish them from the standard subtypes.

Some examples of RP data types are the following:

:datafile.dat:345126:16384^^application&int16

This indicates data in file *datafile.dat* starting at byte address 345126 of length 16384 bytes which are binary data in the 16-bit signed integer format. The system and device on which the file is stored is assumed to be known by context (e.g., the same disk and directory as that which contains the NCCLS LIS 5-A message file which uses this RP).

:/cnp/p123:0:20480^eeg&eeg.xyz.org&DNS^
application&int16

This indicates data in a file identified by the path */cnp/p123* starting at byte address 0 of length 20480 bytes which is binary data in the signed 16-bit integer format on the default device on the system *eeg* which has internet address *eeg.xyz.org*.

4.4.12 *String Data (ST)*—This data type is used to represent items as a simple text string, left justified. String fields are limited in length (typically up to 200 characters), as opposed to TX (text) data, which are virtually unlimited in length.

4.4.13 *Telephone Number Data (TN)*—This data type is used to represent telephone numbers. A field of type TN is a string field with a specific format, as follows:

iii(aaa)ppp-nnnnXeeeeBbbbbCcccc

where **iii** is an optional long distance access code or international country code, **(aaa)** is an optional area (city/region) code enclosed in parentheses, **ppp** is a telephone prefix code, **-nnnn** is a telephone exchange preceded by a hyphen, **Xeeee** is an optional extension number preceded by the letter **X**, **Bbbbb** is an optional beeper or pager number preceded by the letter **B**, and **Ccccc** represents arbitrary text comments about the applicability of the telephone number, preceded by the letter **C**. The length of each part of the telephone number is variable. An example of a TN field is:

```
1(312)959-0800X4790B43905Cafter 5pm or on
Sundays
```

4.4.14 *Time Stamp Data (TS)*—This data type is used to represent a date and optional time, as follows:

```
YYYYMMDDHHMMSS.FF±hhmm
```

where **YYYY** is the four digit year, **MM** is the month number, **DD** is the day, **HH** is the hour (00 to 23) on a 24-h clock, **MM** is the minute, **SS** is the second, **.FF** is the fractional seconds, and **hhmm** represents the number of hours (and minutes, if needed) by which local time is offset from coordinated universal time. The date portion is required; the time portion may not be present if it is not known or relevant (for example, a birth date alone is sufficient for adult subjects, while birth date and time are needed for newborns). Within the time field, the seconds and fractional seconds are optional, and fractional seconds may be of any length (within the total maximal field length). The local time offset is also optional; it is used only if it is necessary to designate the time zone for the given time value.

4.4.15 *Text Data (TX)*—This data type is used for text strings of up to 64K characters (where 1K = 1024), with leading spaces preserved and trailing blanks trimmed. In TX fields, repeat delimiters (~) represent *hard* carriage returns (that is, they display as a carriage return and linefeed), and two repeat delimiters in a row (~~) represent a new paragraph. A receiving system would word-wrap text between repeat delimiters to fit an arbitrarily sized display window, but start text following a repeat delimiter on a new line. The escape character (\) may be used within TX format data fields to signal certain special characteristics of portions of the text field. An *escape sequence* consists of the escape character followed by an escape code ID of one character followed by 0 or more data characters followed by another occurrence of the escape character. Allowable escape sequences defined in the NCCLS LIS 5-A include \H\ (start highlighting) and \N\ (end highlighting, revert to normal text), used to delimit a portion of text to be displayed using underlining or reverse video or a similar technique. They also include sequences used to transmit delimiter characters (which otherwise are not allowed within text fields): \F\ for a field delimiter, \S\ for a component delimiter, \T\ for a subcomponent delimiter, \R\ for a repeat delimiter, or \E\ for an escape character. The escape sequence \Dnnn\ where *nnn* is a three-digit decimal number is used to indicate a special character whose ASCII code is *nnn*; this may be used to transmit control characters or special characters (such as è or ö) which are otherwise not allowed in text fields.

4.4.16 [Deleted]

4.5 *Segment Types*—Table 4-3 lists the NCCLS LIS 5-A segment types (plus the MSA segment added by this Technical Standard), the defined fields of each segment, and their data type, requirement status, and maximum lengths. Only the fields of those NCCLS LIS 5-A segments of most interest to neurophysiology are listed in Table 4-3; refer to NCCLS LIS 5-A for a complete list of fields for all segments. In Table 4-3, fields with a requirement status of *R1* are required to be present in all transmissions. Other fields may not be present under certain circumstances. *R2* fields are required to be present whenever the value they represent is known to the sender (but they may not be present if the information is not known), and *R3* fields are required to be present *unless* the information is not known to the sender *or* is already known to the receiver (the last option should be used with great caution). Fields designated as *O* (optional) by NCCLS LIS 5-A are filled in by the transmitting system only if the information is available and pertinent; otherwise, values for such fields are not present. However, in order to comply fully with this Technical Standard (and regardless of implementation level), a receiving system should be able to accept values for all fields and all segment types defined by this Technical Standard and by NCCLS LIS 5-A without generating an error condition, although the data from *optional* fields or segment types may be ignored or merely logged without further interpretation. Fields not designated as *R1, R2, R3*, or *O* may, in principle, be assigned to any of these categories by mutual agreement of the transmitting and receiving systems, according to the needs of the application. If a transmitting system does not know the intended receiver's requirements, it should treat these fields as optional; similarly, the most general receiving systems should not require the presence of these fields. The following briefly describes the relevant NCCLS LIS 5-A segment types and their fields; refer to NCCLS LIS 5-A for detailed information on each segment and field type.

4.5.1 *Message Header Segment (H)*—This required segment is the first segment of any transmission. R1-required fields include the segment type ID (**H**), the delimiter definition (field, component, repeat, escape, and subcomponent delimiters, where the field delimiter character immediately follows the segment type ID; **|^~\&** for standard delimiters), a message control ID (a text string which uniquely identifies the message, such as a sequence number), the sender ID (an ID code and optional name of the sender), the receiver ID (an ID code and optional name of the receiver; may use the string **ANY** if the intended receiver is not known), a processing ID (**P** for production, **T** for training, or **D** for debugging messages), the version ID which applies to the message format being used (in the form **E.x** where E indicates a message using the electrophysiologic data format described in this Technical Standard and *x* is a number which identifies the particular version of this Technical Standard; the version number *E.3* applies to messages described by this document), and the date and time of the message. A security field (password or encryption key) is an R2-required field. Other fields include the sender street address, sender telephone number (for voice communications), a message type (with two components, a type code and an optional trigger event code which the receiver can use for message routing; allowed type codes and trigger event codes are defined by HL7), characteristics of the sender (such as baud rate or parity), and a comment or special instructions (for example, could be used to identify special-purpose transmissions or locally defined variations of the standard message format).

4.5.2 *Message Acknowledgment Segment (MSA)*—This optional segment is used only in a two-way message transmission system to identify a message returned in response to another message. When an MSA segment is used, it is always the second segment of the response message, following the header (H) segment. R1-required fields include the segment type ID (**MSA**), the acknowledgment code, and the message control ID of the original message (to which this message is a response). The allowed acknowledgment codes are given in Table 4-4. Code **AA** indicates that the original message was accepted and processed successfully. Code **AE** indicates that it was rejected due to a syntax or other error. Code **AR** indicates that it was rejected, either because the message type (if used), processing ID, or version in the message header (H) segment was invalid for the system receiving the message, *or* because of reasons unrelated to the message content (receiver system down, internal error, etc.). The text message field is an R2-required field. It is used when the acknowledgment code was **AE** or **AR** to return an error code and optional text error message (preceded by the string **ERR**) which explains the reason for rejection of the original message (see 9.6). It is also used (with an acknowledgment code of **AA**), in messages which respond to a query for system characteristics or system status, to contain the system characteristics or capabilities in answer to the query (see 9.5.10). In the latter case, this field may contain more than one component. For compatibility with HL7, MSA segment fields 5 and 6 are reserved and will not be used by future versions of this Technical Standard.

4.5.3 [Deleted]

4.5.4 *Patient Identifying Segment (P)*—This segment contains information about an individual patient (subject). R1-required fields include the segment type ID (**P**), a patient segment sequence number (increments from one for each P segment in the message), and a requestor (practice) assigned patient ID. R2-required fields include two requestor (practice) defined special fields. For electroneurophysiologic data transmissions, requestor special field one may be used as desired, but requestor special field two should specify the patient hand, foot, and eye dominance (using keywords **LEFT**, **RIGHT**, **BOTH**, or **UNKNOWN**) as three optional strings separated by repeat delimiters (~). R3-required fields include a producer (diagnostic service) assigned patient ID (may be the same as the requestor assigned patient ID), patient's name, patient's mother's maiden name (when required to distinguish between patients with the same birthdate and last name), patient's birth date/time (time required primarily for neonates), and the patient's sex (**M** for male, **F** for female, or **U** for unknown). Other fields include an alternative patient ID (such as billing number, account number, or social security number), patient's race or ethnic origin (**W** for white, **B** for black, **NA** for Native American, **O** for Oriental, **H** for Hispanic, or **OTH** for other), patient's street address, patient's telephone number, patient's attending physician ID (or multiple IDs separated by repeat delimiters), two producer (diagnostic service) defined special fields, patient's height (default units cm), patient's weight (default units kg), patient's known or suspected diagnoses (as a list separated by repeat delimiters; for example, using ICD-9-CM or SNOMED codes), patient's medications (as a list of generic names separated by repeat delimiters), patient's diet (for example, time food was last ingested), admission date/time and discharge date/time (two subfields separated by a repeat delimiter), patient's admission status (**OP** for outpatient, **PA** for pre-admit, **IP** for inpatient, or **ER** for emergency room), patient's location (such as nursing unit and bed), patient's diagnostic classifications (for example, a list of DRGs in CE format separated by repeat delimiters; coding system name = **DRG**), patient's religion (**P** for protestant, **C** for Catholic, **M** for Church of Latter Day Saints, **J** for Judaism, **H** for Hinduism, or **A** for atheist), patient marital status (**M** for married, **S** for never married, **D** for divorced, **W** for widowed, **A** for separated, **U** for unknown), patient's isolation status (see NCCLS LIS 5-A for possible values), patient's language, patient's confidentiality status (see NCCLS LIS 5-A for possible values), date/time patient registered (or date/time patient registration data was last changed), and date/time of patient's death (if applicable).

4.5.5 [Deleted]

4.5.6 *Order Segment (OBR)*—In a two-way message transmission system, this segment (optionally followed by OBX segments containing data necessary for proper performance or interpretation of the order) may be sent from the requestor (practice) system to the producer (laboratory) system to electronically order an electrophysiologic study to be performed on the subject. This segment (with additional fields supplied) is later returned to the requestor (now receiver) system followed by the requested results of the study; in this case or in a one-way message transmission system, this segment acts as a result header segment. R1-required fields include the segment type ID (**OBR**), an order segment sequence number (increments from one for each OBR segment following a given P segment), a test/observation ID (a code or text string, or both, identifying the test or tests performed and optionally the particular categories of results returned; one or more type CE subfields separated by repeat delimiters), an action code indicating the action taken or to be taken with regard to the order (see 9.3.7 for allowed values), and a requestor (practice) accession number consisting of two components (same as the producer accession number in a one-way message transmission system); the first component uniquely identifies the order (increments continuously for each new order made from the time of system installation) and the second identifies the requesting application (constant for any given requestor system). R2-required fields include a producer (diagnostic service) accession number with two components, the first of which uniquely identifies the study performed (increments continuously for each new study performed from the time of system installation) and the second of which identifies the producer application (constant for any given laboratory system), the test/observation begin date/time (the starting date and time of the study), two requestor (practice) defined special fields, the date and time observation reported or status changed (date/time of test interpretation and result reporting or date/time the order result status changed), the order result status code (see 9.3.10 for allowed values), quantity/timing information (with ten optional components defining quantity, interval, duration, start date/time, end date/time, priority, condition, text comments, conjunction, and order sequencing; used for ordering repetitive or timed tests; see NCCLS LIS 5-A for details), and a link to parent order that is used when a parent order spawns multiple secondary orders; this last field consists of two components, the first of which identifies the parent order by its requestor accession number (two subcomponents) and the second of which identifies the parent order by its producer accession number (two subcomponents). Other fields include the requested date/time (date and time the test was requested or ordered), the test/observation end date/time (date and time the study was completed), danger code (subject-specific hazards to laboratory personnel, with two components: an optional alphanumeric code and a text description), relevant clinical information (has two components: an optional alphanumeric code and a text description), the ordering physician ID and ordering physician telephone number, two producer (diagnostic service) defined special fields, producer (diagnostic service) charge for the study (has three components: a monetary amount, a billing code, and a currency code), the producer (diagnostic service) section ID (see NCCLS LIS 5-A for all allowed values; **EN** for electroneurophysiology laboratories), *send copies to* list (list of persons who need copies of the study results; multiple subfields separated by repeat delimiters), transportation mode (**PORT** for portable study, **CART** if patient travels by cart, **WHLC** if patient travels by wheelchair, **WALK** if patient can walk), reason for study (for example, one or more *rule-out* diagnoses separated by repeat delimiters), principal interpreter of study, assisting interpreter of study (for example, resident), technician identity, transcriptionist identity, date/time test scheduled, and other fields which are specimen-related and not applicable to most neurophysiologic tests.

4.5.7 *Result Segment (OBX)*—One or more result segments containing some or all of the data generated during a study are generally transmitted following an order segment (acting as a result header) in a message used to return the results of a study to the ordering system (or to any system used to review the data from the study). One or more result segments containing status or error information in response to a query about an order may also be transmitted following an order segment in a message used to respond to the query. Finally, one or more result segments containing data required for proper performance or interpretation of a study (such as equipment settings, for example, montage and channel definitions) may also be transmitted following an order segment in a message used to electronically order a study. The fields in the result segment are explained in detail in Section 5.

4.5.8 *Error Checking Segment (E)*—This optional segment provides for simple error checking within a message. All fields are R1-required and include the segment type ID (**E**), error segment sequence number (increments from one for each E segment in a message), error check byte count (byte count for data transmitted since the last error checking segment or the start of the message, except carriage returns), and a check code (exclusive OR of all character codes except carriage returns in the transmission, expressed as a three-digit decimal number).

4.5.9 *Comment Segment (C)*—This optional segment contains only R1-required fields including the segment type ID (**C**), a comment segment sequence number (increments from one for each C segment in a message), a comment source which is either **P** (practice or requestor) or **L** (laboratory or producer), and comment text related to the immediately preceding patient, order, result, or request segments. It may be used, for example, to specify additional detail about electrodes, channels, filters, stimulus paradigms, annotations or analyses, etc., which cannot be expressed in the currently defined field structure of result (OBX) segments. It is not to be used for annotations to waveform data (often technician generated) related to the behavior of the subject or events during the performance of the electrophysiologic procedure itself (the ANA category result segment is used for these comments). The receiving system usually logs or retains comment segments, along with the preceding segment to which they apply, for inspection.

4.5.10 *Request Results Segment (Q)*—This optional segment is used only in a two-way message transmission system when one system wishes to request information from another system regarding tests and test results, orders, lists of patients or tests, or system characteristics. The results of the query are returned in an acknowledgment message sent by the queried system to the querying system. The format of the acknowledgment message depends on the query (that is, on the particular results to be returned). Some queries can be answered in the MSA (message acknowledgment) segment alone. Others require additional segment types, including P (patient), OBR (order), and OBX (result) segments. Specific query types include the following. A request results (Q) segment may be used when a requestor (data receiving) system wishes to request, from the producer (laboratory or data sending) system, results of tests previously ordered and possibly previously reported. It may also be used to query the producer system about the status of a previously ordered but not yet reported test or individual test result, about the status of active functions related to a test in progress on a system, or about equipment settings (such as current montage and channel definitions). The answer to the query is returned in the order result status field of an OBR segment or in one or more OBX segments. A single request results segment may ask for all or some of the results for a given test or multiple tests, specified as a list. Alternatively, it may request results for all tests performed on a single date, a series or range of dates, and for an individual subject, groups of subjects, or all subjects. In addition, a request results segment may be used when one system wishes to request from another system new or current order information, a patient list or patient demographic data, or test/observation master data describing the types of tests which can be performed by the laboratory. In this case, the answer to the query may be a message containing one or more patient (P), or order (OBR) segments. Also, a request result segment may be used when one system wishes to request information about the characteristics, operational status, configuration, or capabilities of another system. The answer to such a query is returned in the text message field of a message acknowledgment (MSA) segment in the response message. Finally, a request segment may be used when one system wishes to remotely control a process on another system, or cancel a transmission of result data in progress. R1-required fields in a request results segment include the segment type ID (**Q**) and a request results segment sequence number (increments from one for each Q segment in a message). R2-required fields include requestor (practice) assigned patient IDs (multiple entries separated by repeat delimiters), producer (diagnostic service) assigned patient IDs (multiple entries separated by repeat delimiters), test/observation IDs (multiple entries separated by repeat delimiters), and the requesting physician ID. Optional (**O**) fields include the beginning request results date and time (or several individual dates and times; one or more entries separated by repeat delimiters) and the ending request results date and time (these may be used, for example, when requesting a brief segment of electrophysiologic waveform data to specify the starting and ending time of the requested segment), and a code indicating the nature of the request time limits (**S** for study date or **R** for report date). Other fields include the requesting physician telephone number, and two requestor (practice) defined special fields. Requestor special field 1 can be used as desired. Requestor special field 2 is a multicomponent field that contains a subject filter and optional qualifiers (which together defined the type of query).

4.5.11 [Deleted]

4.5.12 *Message Terminator Segment (L)*—This required segment is the last in any message and indicates the logical end of the message. R1-required fields include the segment type ID (**L**) and message terminator segment sequence number (always one since there can be only one terminator segment per message). Other fields are used to check message integrity and include a patient count (number of patient segments transmitted in the message), line count (number of lines, that is, number of carriage returns in the message), and a batch number (assigned by the sender to identify the entire transmission; may be the same as the message control ID in the header segment).

4.6 *Overall Message Logical Structure:*

4.6.1 Table 4-5 presents the overall logical structure of a NCCLS LIS 5-A message in terms of its component segments arranged in a hierarchical fashion.

4.6.2 In this logical message structure, segments at the highest level (level 0) of the hierarchy define the message boundaries (message header and trailer segments). Message acknowledgment segments (used in response messages in two-way communication systems) follow message header segments and also occupy level 0 of the hierarchy. Segments at the first level contain information about individual patients (patient identifying segments). Segments at the second level contain information about a particular test or study (order segments). Segments at the third level contain individual test results or observations (result segments). Query (**Q**) segments, when used, take the place of patient identifying segments at the first level. A sequence of patient identifying segments, order segments, or result segments at one level is terminated by the appearance of a segment type of the same or higher level. Thus, for example, a sequence of result segments (**OBX**) for one test is terminated by the next order (**OBR**), patient identifying (**P**), or request results (**Q**) segment or by a message terminator (**L**) segment. An order (OBR) segment may never appear without a preceding patient identifying (P) segment, and a result (OBX) segment may never appear without a preceding order (OBR) segment. The comment (**C**) and error checking (**E**) segments may be inserted at any level and do not terminate the current level.

4.7 *Test/Observation Identifiers:*

4.7.1 The test/observation identifiers (same as observation battery or observation identifiers in NCCLS LIS 5-A nomenclature) are coded entry (CE) data items used to identify specific tests (batteries), individual portions of tests, or individual test results (observations) in order segments, request results segments, and result segments. In order (OBR) and request results (Q) segments (but not in result segments), multiple test/observation identifiers may be supplied to order or request multiple tests or subtests; each test/observation identifier is separated from the others by a repeat delimiter (~). ACNS Technical Standard 1 and NCCLS LIS 5-A (**AS4**) universal alphanumeric codes (coding system **AS4&TEST**) are the default for Code 1 in the CE data field, and are based on CPT-4. Other coding systems may be used (such as CPT-4 codes without modifiers, coding system **C4**, or local codes defined by a particular laboratory or institution, coding system **L**), but the **AS4** coding system is preferred. NCCLS LIS 5-A defines universal test/observation ID codes for clinical chemistry, hematology, microbiology, and similar laboratory results, for spirometry, ultrasound, chest X-ray, endoscopy, physical exam and medical history (including neurologic examination and history), physiologic measurements, cardiac catheterization, coronary angiography, electrocardiography, and other clinical tests or procedures. Appendix B of this Technical Standard defines the **AS4** universal test/observation ID codes for various classes of electroneurophysiologic studies. It may be noted that *all* medical information available for a given subject may be transmitted in a single message, if desired; thus, one transmission may include intermixed order (OBR), result (OBX), or request result (Q) segments using test/observation IDs defined by NCCLS LIS 5-A and using test/observation IDs defined in Appendix B of this Technical Standard; CPT-4 codes not mentioned in either NCCLS LIS 5-A or in Appendix B may also be used if necessary. CPT-4 codes may be identified either by the coding system mnemonic identifier **C4** (which specifically indicates CPT-4 codes without modifiers) or **AS4** (which may be used to indicate either modified CPT-4 codes or unmodified CPT-4 codes); thus, **C4** codes are a proper subset of **AS4** codes.

4.7.2 The test/observation ID specified in an order (OBR) segment used to order electrophysiologic studies in a two-way message transmission system is often a generic code (whose scope is determined by local norms and individual laboratory practice) or a set of several individual specific or generic codes separated by repeat delimiters, to indicate an order for multiple individual specific tests or any relevant tests within a class of related studies (often to be chosen at the discretion of the laboratory according to local custom and the individual needs of the subject). When such a *parent* order is received by the laboratory system, it leads to the generation internally of multiple *child* orders; when a response message is returned to the ordering computer system containing the study results, each individual specific study performed would be transmitted as an OBR segment containing a specific test/observation ID for that study, followed by many OBX segments containing the study results including waveform data. For example, one could order generic *EMG studies* by transmitting a message containing an OBR segment with the appropriate test/observation ID (9586X using **AS4** universal codes), and the response message containing the study results could include three separate OBR segments defining a motor nerve conduction study (test/observation ID code 95900 using AS4/CPT-4 universal codes), a sensory nerve conduction study (code 95904), and a one extremity EMG (code 95860), together with the corresponding OBX (result) segments (see Appendix C for a complete example). This is analogous to the example given in NCCLS LIS 5-A of a *parent* order for *Routines* being expanded into *child* orders for urinalysis, complete blood count, and electrolytes by a particular laboratory computer system.

4.7.3 The alphanumeric code in the first and fourth components of the test/observation ID field is often followed by an alphabetic information category code; a subcomponent delimiter (**&**) is used between the alphanumeric test code and the alphabetic information category code. For example, a diagnostic impression could have the identifier **95816&IMP** using **AS4** universal codes.

4.7.4 The use of an information category code is optional in order segments and in request result segments transmitted in a two-way message system to order a test or obtain the results of a previously performed test; its presence in this context implies that only the result segments with the given information category code are to be returned to the requesting system (in contrast to the usual situation in which an information category code is not present, and result segments with all information category codes are therefore returned). If multiple test/observation identifiers separated by repeat delimiters (~) are used in order (OBR) and request results (Q) segments, the alphanumeric code may not be present before the information category code in the second and subsequent identifiers if the alphanumeric code used in the previous test/observation identifier applies. This may be used to request transmission of result segments with a number of different information category codes. In this context, a subfield which is not present (that is, two repeat delimiters in a row) may be used to request transmission of result segments with no information category code (those which return individual quantitative or qualitative test results). For example, a report, interpretation, diagnostic impression, all quantitative and qualitative individual test results, and recommended follow-up tests (but not the digital waveform or technical data) could be ordered to be transmitted using the following string of test/observation identifier codes:

```
95816&GDT~&MDT~&IMP~~&REC
```

TABLE 4-1 Mnemonic Identifiers of Coding Systems

Mnemonic	Description
All Coding Systems	
99zzz or L	Locally defined codes (where each *z* represents an alphanumeric character); a specific mnemonic *zzz* may be used to distinguish between different locally defined coding systems in use at one site, or the letter **L** may be used if there is only one locally defined coding system; also, a specific code table identifier may be used which is unique to each laboratory or application in a given site (identified by the sending system ID in the message header).
Diagnostic Impression Coding Systems	
I9C	ICD-9-CM (International classification of diseases, 9th revision, clinical modification) diagnosis codes.
I10	ICD-10 (International classification of diseases, 10th revision) diagnosis codes.
SNM	SNOMED (Systemized Nomenclature of Medicine) diagnosis codes, one of the seven currently defined axes of SNOMED (specific code table identifier **DIAG**).
ICSD	ICSD (International Classification of Sleep Disorders) diagnosis codes.
AS4	ACNS Technical Standard 1 universal diagnosis codes, defined in Appendix B (specific code table identifiers **BAED**, **DVED**, **ECOD**, **EEGD**, **EMGD**, **ERGD**, **LAED**, **MAED**, **MNCD**, **MRPD**, **MSED**, **NMJD**, **PSED**, **SEPD**, **SNCD**, **SSED**, **TSED**, and **VEPD**).
Anatomic (topographic) Localization Coding Systems	
SNM+	SNOMED (Systemized Nomenclature of Medicine) topographic codes, one of the seven currently defined axes of SNOMED, extended with qualifiers; those most applicable to electroneurophysiology are listed in Appendix A (specific code table identifier **TOPO**).
AS4	ACNS Technical Standard 1 universal anatomic distribution (localization) codes, defined in Appendix B (specific code table identifier **DIST**).
Test/Observation ID Coding Systems	
AS4	ACNS Technical Standard 1 universal test/observation ID codes, defined in NCCLS LIS 5-A and in Appendix B (specific code table identifier **TEST**).
C4	CPT-4 (Physicians' Current Procedural Terminology, 4th edition) test codes.
Individual Test Result Coding/Grading Systems	
AS4	ACNS Technical Standard 1 universal test result codes, defined in Appendix B (specific code table identifiers **ABUN**, **ASYM**, **COLO**, **DIST**, **LOHI**, **MRPH**, **PATT**, **REAC**, **RELA**, **RTHM**, **SHLO**, **SMLG**, **STAG**, **TMPM**, and **WAVE**).
Units of Measure Coding Systems	
ISO+	Extended SI units standard single case abbreviations.
ANS+	Extended U.S. customary units standard single case abbreviations.
Producer Identifier Coding Systems	
MCR	Medicare/CMS's universal producer numbers (unique codes for each medical facility or laboratory in the United States).
UPIN	Medicare/CMS's universal physician identification numbers (unique codes for each physician or health care provider in the United States).
Drug/Medication Coding Systems	
W1	World Health Organization record number codes (six-digit format); these codes are unique for each single component and multicomponent drug.
W2	World Health Organization record number codes (eight-digit format); these codes add an additional two digits to the **W1** codes to identify the salt of single content drugs.
Medical Device Coding Systems	
UMD	Universal Medical Device Nomenclature System (MDNS) codes; these codes are unique for each type of biomedical device, but do not uniquely identify a particular make or model.

TABLE 4-2 Main Types and Corresponding Subtypes of Referenced Data

Main Type	Subtype	Description
Image	TIFF	TIFF image data
	PICT	PICT image data
	DICOM	Digital Imaging and Communications in Medicine data
	FAX	Facsimile data
	JOT	Electronic ink data (Jot 1.0)
	JPEG	Joint Photographic Experts Group data
	GIF	Graphics Interchange Format data
Audio	BASIC	ISDN PCM audio data
Application	PostScript	PostScript program data
	HTML	Hypertext Markup Language data
	RTF	Rich Text Format data
	Octet-stream	Uninterpreted binary data as 8-bit byte stream
	Int08	Binary signed (two's complement) 8-bit integers
	Int16	Binary signed (two's complement) 16-bit integers with least significant byte before most significant byte (corresponding to "short int" format in C or C++ on Intel and compatible platforms)

TABLE 4-3 Synopsis of NCCLS LIS 5-A Segments and Field Names
Key: T=Type, R=Required, ML=Maximum Length

Mnemonic	Field Name	T	R	ML
Message Header Segment (H)				
H-1	Segment type ID	ST	R1	3
H-2	Delimiter definition	ST	R1	5
H-3	Message control ID	ST	R1	12
H-4	Security	ST	R2	12
H-5	Sender ID	ST	R1	40
H-6	Sender street address	AD		100
H-7	Message type	CM		7
H-8	Sender telephone number	TN		40
H-9	Characteristics of sender	ST		40
H-10	Receiver ID	ST	R1	40
H-11	Comment or special instructions	ST		80
H-12	Processing ID	ID	R1	20
H-13	Version	ST	R1	5
H-14	Date/time of message	TS	R1	26
Message Acknowledgment Segment (MSA)				
MSA-1	Segment type ID	ST	R1	3
MSA-2	Acknowledgment code	ID	R1	2
MSA-3	Message control ID	ST	R1	12
MSA-4	Text message	CM	R2	200
Patient Identifying Segment (P)				
P-1	Segment type ID	ST	R1	3
P-2	Patient segment sequence number	NM	R1	4
P-3	Requestor (practice) assigned patient ID	CK	R1	16
P-4	Producer (diagnostic service) assigned patient ID	CK	R3	16
P-5	Alternative patient ID	ST		16
P-6	Patient name	PN	R3	48
P-7	Patient mother's maiden name	ST	R3	24
P-8	Patient birth date/time	TS	R3	26
P-9	Patient sex	ID	R3	1
P-10	Patient race or ethnic origin	ID		40
P-11	Patient street address	AD		200
P-12	[Not used]			0
P-13	Patient telephone number	TN		40
P-14	Patient attending physician ID	CNA		60
P-15	Producer (diagnostic service) special field 1	ST		60
P-16	Producer (diagnostic service) special field 2	ST		60
P-17	Patient height	CQ		10
P-18	Patient weight	CQ		10
P-19	Patient known or suspected diagnoses	CE		200
P-20	Patient medications	ST		200
P-21	Patient diet	ST		200
P-22	Requestor (practice) special field 1	ST	R2	60
P-23	Requestor special field 2 (hand/foot/eye dominance)	ST	R2	60
P-24	Admission date/time and discharge date/time	TS		53
P-25	Patient admission status	ID		2
P-26	Patient location	ST		25
P-27	Patient diagnostic classification	CE		100
P-28	Patient religion	ID		30
P-29	Patient marital status	ID		2
P-30	Patient isolation status	ID		20
P-31	Patient language	ST		20
P-32	Patient confidentiality status	ID		20
P-33	Date/time patient registered	TS		26
P-34	Patient death date/time	TS		26

TABLE 4-3 *Continued*

Mnemonic	Field Name	T	R	ML
Order Segment (OBR)				
OBR-1	Segment type ID	ST	R1	3
OBR-2	Order segment sequence number	NM	R1	4
OBR-3	Requestor (practice) accession number	CM	R1	75
OBR-4	Producer (diagnostic service) accession number	CM	R2	75
OBR-5	Test/observation ID	CE	R1	200
OBR-6	[Not used]			0
OBR-7	Requested date/time	TS		26
OBR-8	Test/observation begin date/time	TS	R2	26
OBR-9	Test/observation end date/time	TS		26
OBR-10	Specimen collection volume	CQ		20
OBR-11	Specimen collector ID	CNA		60
OBR-12	Action code	ID	R1	1
OBR-13	Danger code	CM		60
OBR-14	Relevant clinical information	CM		300
OBR-15	Date/time of specimen receipt	TS		26
OBR-16	Source of specimen	CM		300
OBR-17	Ordering physician	CNA		60
OBR-18	Ordering physician telephone number	TN		40
OBR-19	Requestor (practice) special field 1	ST	R2	60
OBR-20	Requestor (practice) special field 2	ST	R2	60
OBR-21	Producer (diagnostic service) special field 1	ST		60
OBR-22	Producer (diagnostic service) special field 2	ST		60
OBR-23	Date/time observation reported or status changed	TS	R2	26
OBR-24	Producer (diagnostic service) charge	CM		60
OBR-25	Producer (diagnostic service) section ID	ID		10
OBR-26	Order result status code	ID	R2	1
OBR-27	Link to parent result	CM		200
OBR-28	Quantity/timing	CM	R2	200
OBR-29	Send copies to	CNA		150
OBR-30	Link to parent order	CM	R2	150
OBR-31	Transportation mode	ID		20
OBR-32	Reason for study	CE		300
OBR-33	Principal interpreter of study	CNA		60
OBR-34	Assisting interpreter of study	CNA		60
OBR-35	Technician identity	CNA		60
OBR-36	Transcriptionist identity	CNA		60
OBR-37	Date/time scheduled	TS		26
Result (Observation) Segment (OBX)				
OBX-1	Segment type ID	ST	R1	3
OBX-2	Result segment sequence number	NM	R1	10
OBX-3	Value type	ID	R1	2
OBX-4	Test/observation ID	CE	R1	590
OBX-5	Observation subID	ST	R2	20
OBX-6	Observation value (result)	(variab.)	R3	64K
OBX-7	Units of measure	CE	R3	590
OBX-8	Reference range	ST	R3	60
OBX-9	Abnormal/change flags	ID	R3	10
OBX-10	Probability	NM		5
OBX-11	Nature of abnormal testing	ID		5
OBX-12	Observation result status	ID	R3	2
OBX-13	Date/time of last change in normals/units	TS	R3	26
OBX-14	User-defined access checks	ST		20
OBX-15	Physiologic observation date/time	TS		26
OBX-16	Producer ID	CE		200
OBX-17	Responsible observer	CNA		60
Error Checking Segment (E)				
E-1	Segment type ID	ST	R1	3
E-2	Error checking segment sequence number	NM	R1	4
E-3	Error check byte count	NM	R1	10
E-4	Check code	NM	R1	3
Comment Segment (C)				
C-1	Segment type ID	ST	R1	3
C-2	Comment segment sequence number	NM	R1	4
C-3	Comment source	ID	R1	8
C-4	Comment text	TX	R1	64K
Request Results Segment (Q)				
Q-1	Segment type ID	ST	R1	3
Q-2	Request results segment sequence number	NM	R1	6
Q-3	Requestor (practice) assigned patient ID	CK	R2	200
Q-4	Producer (diagnostic service) assigned patient ID	CK	R2	200
Q-5	Test/observation ID	CE	R2	200
Q-6	Nature of request time limits	ID	O	10
Q-7	Beginning request results date/time	TS	O	100
Q-8	Ending request results date/time	TS	O	100
Q-9	Requesting physician	CNA	R2	60
Q-10	Requesting physician telephone number	TN		40
Q-11	Requestor (practice) special field 1	ST		80
Q-12	Requestor special field 2 (subject filter and qualifiers)	CM		80
Message Terminator Segment (L)				
L-1	Segment type ID	ST	R1	3
L-2	Message terminator segment sequence number	NM	R1	1
L-3	[Not used]			0
L-4	Patient count	NM		4
L-5	Line count	NM		10
L-6	Batch number	ST		12

TABLE 4-4 Acknowledgment Codes

Code	Meaning
AA	Application accept
AE	Application error
AR	Application reject

TABLE 4-5 Logical Structure of a Message

Message header	(information about the transmission)
Message acknowledgment	(optional, for two-way communication)
Patient 1	(general information about first patient)
Order 1	(information about the first ordered test)
Result 1	(first result segment for first test)
Result 2	(second result segment)
...	
Result n_1	(last result segment for first test)
Order 2	(information about the second ordered test)
Results $1..n_2$	(similarly to Results $1..n_1$ for Order 1)
...	
Order m	(information about the last ordered test)
Results $1..n_m$	
Patient 2	(general information about second patient)
...	(all of the structure repeats)
Message trailer	(indicates the end of the overall message)

5. Descriptions of Fields in Result Segments

5.1 Result (OBX) segments have a format defined by NCCLS LIS 5-A. The fields contained in result segments, their data types and maximum lengths, and their usage are defined in 5.2 through 5.18.

5.2 *Segment Type ID*—This R1-required field (data type ST, maximum length three characters) contains the characters **OBX**, signifying a result segment containing observations.

5.3 *Result Segment Sequence Number*—All result segments following a given order (OBR) segment are numbered sequentially beginning with one. This R1-required field contains the decimal sequence number (data type NM, maximum length 10 characters).

5.4 *Value Type*—This R1-required field (data type ID, maximum length two characters) defines the data type or structure of the observation value field (field 6). Many of the valid data types are described in this Technical Standard (see 4.4), and others are described in the NCCLS LIS 5-A. Those which are used most often in electrophysiologic study result segments are summarized in Table 5-1.

5.5 *Test/Observation ID:*

5.5.1 This R1-required field contains a test/observation identifier in coded entry (CE) format. The test/observation ID identifies both the general category of study and a more specific type of study or a specific portion of a study, and it may identify also a particular quantitative or qualitative study result. The test/observation ID field may change in successive result segments transmitted during the course of the recording as different subtests or portions of the study are performed (for example, awake, sleep, hyperventilation, photic stimulation in an EEG, or studies on various different muscles in an EMG). When the result segments are all labeled in this fashion, it becomes possible to search automatically for a desired portion of the recording. The receiving system may even generate an index into the recording as result segments are received, to allow faster random access to the desired portion of the data. The first component is required in all result segments; the other components need not be present.

5.5.2 The first and fourth components of the test/observation ID consist of an alphanumeric code and, in some cases, an information category code separated from the alphanumeric code by a subcomponent delimiter (**&**).

5.5.3 The second and fifth components of the test/observation ID are text strings describing the test, portion of test, or individual quantitative or qualitative study result identified by the first and fourth components. To save space, the second and fifth components may not be present in result segments in which the first and fourth components are exactly the same as in the previous result segment; in this case, the text descriptions can also be assumed to have remained the same since the previous result segment. The second and fifth components of the test/observation ID may also not be present if the receiving system is known to be a Level III system which can reconstruct the text description from the alphanumeric codes given in the first and fourth components, or if the transmitting system itself does not know the text description of the alphanumeric code.

5.5.4 The third and sixth components of the test/observation ID are strings identifying the coding system used in the first and fourth component. When not present, the default for the third component is **AS4&TEST** (**AS4** universal codes, as listed in Appendix B). The default for the sixth component is **L** (local codes). The maximum total length of the test/observation ID field is 590 characters, which includes 80 characters each for components 1 and 4, 200 characters each for components 2 and 5, and 12 characters each for components 3 and 6.

5.5.5 The information category code that usually follows the alphanumeric code defines the nature and format of the data contained in the result segment's observation value field. Table 5-2 presents the information category codes and their corresponding value types defined for electrophysiologic study data.

5.5.6 The only time that an information category code is *not* present in a result segment is when transmitting single quantitative or qualitative test results, such as velocities, latencies, amplitudes, peak or waveform morphologies, etc. These results have a value type of NM (numeric) or CE (coded entry). Numeric results are sent along with their units of measure, the normal range defined by the laboratory (if applicable), and abnormal/change flags.

5.5.7 Test/observation IDs in result segments that do not contain an information category code must fully specify the particular final test result of type NM or CE which is transmitted in that segment. Test/observation IDs in result segments of type TIM, WAV, STM, TCM, MED, and ANA (and often ANT and IMP as well) should identify the particular portion of the study to which the results apply. Test/observation IDs in result segments with information category codes of ELC, MTG, CHN, DST, and SEL should identify only the study as a whole, because these segments contain data which define recording conditions that may apply to several different portions of the study. Similarly, test/observation IDs in result segments with information category codes of CNP, DEV, SER, and REC (and often GDT, MDT, ADT, ANT, and IMP) should identify only the study as a whole, since these segments generally specify data that applies to all parts of the study. Finally, test/observation IDs in result segments with information category codes of ERR and STA should identify only the study as a whole.

5.6 *Observation SubID*—This R2-required field (data type ST, maximum length 20 characters) uniquely identifies each OBX segment following a given OBR segment; it may be absent only if the OBX segment is already uniquely identified by its information category code or test/observation ID. If there are multiple OBX segments (with logically independent data) having the same information category code (regardless of test/observation ID) or having the same test/observation ID with information category codes which are not present, they must be numbered sequentially from one and this number used as the observation subID. More than one OBX segment with the same test/observation ID, information category, and observation subID may occur only when transmitting a single result in two forms, for example, in numeric and coded entry format.

5.7 *Observation Value (Result)*—This R3-required field, which may contain multiple subfields, components, and subcomponents, contains the actual results. The data type of this field is given in the value type field (field 3) of the result (OBX) segment. The format of this field is described in Sections 6 through 9 for each category of result segment. The maximum length of this field is 64K characters.

5.8 *Units of Measure*—This R3-required field (data type CE) describes the units in which the result in the previous field is expressed. It contains a coded entry in the six-component format defined by NCCLS LIS 5-A. The first and fourth components would contain standard abbreviations for the units of measure using a standard coding system, the second and fifth components could contain corresponding longer text descriptions of the units, and the third and sixth components could contain an identification of the coding system used in the first (the default is **ISO+**, but **ANS+** is an alternative) and fourth (the default is **L**, local codes) components. The coding system mnemonic identifier **ISO+** indicates standard single case abbreviations of SI units (ISO 2955-1983), while **ANS+** indicates standard single case abbreviations of U.S. customary units (ANSI X3.50-1986) not included in the ISO set; two special units (pha and tur) defined in this Technical Standard for electrophysiology may be used as well. Derived units may also be used as described in 4.3.9. Units of measure are used only in result segments that return a single numeric result such as a velocity, latency, or amplitude. The maximum length of this field is 590 characters, which includes 80 characters each for components 1 and 4, 200 characters each for components 2 and 5, and 12 characters each for components 3 and 6.

5.9 *Reference Range*—This R3-required field (data type ST, maximum length 60 characters) is used only in result segments that return a single numeric test result. It contains the laboratory-specific normal range for the result value. This may be expressed in the form *low-high* (for example 105.5-125.3). If the lower or upper bounds are negative, they may be preceded by a minus sign (for example, -12.2--6.5). If the range includes no upper bound, the format >*low* is used (for example, >20.5). If the range includes no lower bound, the format <*high* is used (for example, <14).

5.10 *Abnormal/Change Flags*—This R3-required field (data type ID, maximum length ten) indicates the normalcy status of the results or changes since the last performance of the test. The keyword values (defined by NCCLS LIS 5-A) which are most useful for electrophysiologic study data are given in Table 5-3.

5.10.1 The < and > flags may be used in result segments with information category codes of WAV (digital waveform data) to indicate that one or more digitized data values were outside the range of the analog-to-digital converter (ADC); the use of this field in this context is optional. The **N**, **A**, **B**, and **W** codes may be used in result segments with information category code IMP to indicate whether the diagnostic impression for this study is normal, abnormal, better, or worse, or in result segments that report qualitative data such as peak or waveform morphologies using a coded entry format. The **L, H, N, A, U, D, B**, and **W** flags may be used in result segments that report velocities, latencies, amplitudes, or other single numeric values. Multiple codes can be specified, separated by repeat delimiters (for example, **H~W**).

5.11 *Probability*—This field (usually considered optional for all implementation levels) can be used to report the probability of a diagnostic impression (in a result segment with information category code IMP) as a decimal number between zero and one (data type NM, maximum length five characters).

5.12 *Nature of Abnormality Testing*—This field (used only in result segments that return a single numeric result, and usually considered optional for all implementation levels) indicates the kind of normative data employed by the laboratory, using the representations given in Table 5-4 (data type ID, maximum length five characters). As many of the codes as apply may be included, separated by component delimiters. For example, normal values based on age, sex, and race would be coded as **A^S^R**.

5.13 *Observation Result Status:*

5.13.1 This R3-required field (data type ID, maximum length two characters) defines the status of the data being transmitted and determines the action of the receiving system. For this Technical Standard, a default value (**F**) is defined which is used when this field is not present. The keyword codes defined by the NCCLS LIS 5-A are given in Table 5-5.

5.13.2 Codes **P**, **R**, or **U** could be used in result segments with information category codes ANT, IMP, REC, GDT, MDT, or ADT, or in segments that do not have an information category code. Codes **X** and **I** could be used in a result segment (with an observation value field which is not present) to flag explicitly ordered subtests (for example, a sleep portion of an EEG) which could not be performed or which have not yet been performed. Result segments with any of these codes would be specially flagged by a receiving system when displayed or stored. An immediately following comment (C) segment could be transmitted to explain the reason for the **X** or **I** code.

5.13.3 Codes **C** and **D** may be used with any result segment when a change to previous data is intended, and are interpreted as follows by a receiving system. Code **C** indicates that data contained in the observation value (result) field of the segment so flagged are to replace previously transmitted data with the same test/observation ID and information category code and observation subID.

5.13.4 Code **D** indicates that data previously transmitted in a result segment with the same test/ observation ID and information category code and observation subID should be deleted (marked *not present*). When changing or deleting a result previously transmitted in an OBX segment, the particular result affected is identified by the test/observation ID code and observation subID (if needed). For this purpose, multiple OBX segments with the same test/observation ID and observation subID are replaced or deleted as a unit.

5.13.5 Codes **C** and **D** are not used when transmitting changes to electrode definition (ELC category), montage definition (MTG category), or channel definition (CHN category) result segments, since result segments in these categories are normally assumed to specify changes to previously transmitted electrode, montage, or channel information, if any. Codes **C** and **D** are also not usually used with TIM, WAV, DST, STM, TCM, MED, ANA, SEL, ERR, or STA category result segments since data contained in these segments do not replace or supersede previously transmitted data. (An exception to this rule that applies to retransmitting results following detection of a transmission error is described in 9.5.20.9.) The **C** and **D** result status codes are primarily used in applications in which results previously stored in a database need to be updated. This may apply to result segments that do not contain an information category code or to DEV, SER, CNP, ANT, IMP, GDT, MDT, ADT, and REC category result segments.

5.14 *Date/Time of Last Change in Normals/Units*—This R3-required field (used only in result segments that return a single numeric result) is not present unless there has been a recent change in the normal values or units pertaining to data in the result segment, in which case the date and time (in the standard date-time format) of the change are encoded (data type TS, maximum length 26 characters). A change in this date and time compared to that recorded in the receiving system's database could trigger a manual review of the results, for example.

5.15 *User-Defined Access Checks*—This field (usually considered optional for all implementation levels) can be used to specify a special-purpose code classifying the data in the result segment for the purpose of controlling access to or later processing of the data. For example, certain WAV category result segments could be flagged using this field by one code which indicates that the data satisfy some criteria (determined by the transmitting system) for printing on a hard copy device; other result segments could be flagged using this field by another code which indicates that the data should be excluded from special processing such as averaging or frequency spectral analysis (for example, because of excessive artifact). A system receiving the data which was aware of these special codes could then selectively print, not print, process, or ignore the data depending on the contents of this field. The uses of and possible values for this field are left entirely to an agreement between the sending and receiving applications that is beyond the scope of this Technical Standard. The use of this field is therefore to be considered non-portable and nonstandard.

5.16 *Physiologic Observation Date/Time*—This field (usually considered optional for all implementation levels) can be used in result segments that do not have an information category code (those used to return a single numeric or coded result) if it is necessary to specify the date/time at which the result was measured. It could be used, for example, to indicate the date/time at which a body temperature measurement was made, when this is relevant to the interpretation of the study. It is not to be used to indicate the date/time that characterizes waveform data or other data directly associated with the waveform data (such as technical comments) since the TIM category result segment is used for this purpose, as described in 6.5.1. It is also not necessary to specify a date/time for result segments containing reports and interpretations derived from analysis of the entire study, since the study beginning and ending times are specified in the OBR segment (fields OBR-8 and OBR-9, respectively).

5.17 *Producer ID*—This field (usually considered optional for all implementation levels) may be used to specify the identity of the laboratory at which the data in the result segment was acquired or generated, using a coded entry (CE) data format. The first and fourth components specify unique codes for the laboratory. The second and fifth components specify text strings identifying the laboratory specified in the first and fourth components. The third and sixth components specify the coding system used in the first (the default in the United States is **MCR**, Medicare/CMS's universal provider numbers**(8)**) and fourth (the default is **L**, indicating local codes) component. If this field is not present, the receiving system may assume that the data in the result segment was generated by the transmitting organization. Thus, this field need only be used when the data originated elsewhere. For example, when an EEG tracing performed elsewhere is interpreted by a laboratory and the original waveform data and annotations are transmitted to another party along with the resulting interpretation and report from that laboratory, the result segments defining waveform data and annotations would contain the ID of the original laboratory performing the study in field OBX-16, while this field would be omitted in segments used to transmit the report and interpretation.

5.18 *Responsible Observer*—This field (usually considered optional for all implementation levels) may be used to specify the individual directly responsible for the data in the result segment. For waveform data and annotations, this is usually the technician or physician who performed the study. For reports, interpretations, and analyzed data, this is usually the physician who interpreted the waveform data and generated the report. Since the information about the principal and assisting interpreter and technician is contained in fields OBR-33, OBR-34, and OBR-35 of the preceding order segment, this field need only be used if different technicians or physicians participated in different portions of the study, and it is necessary to associate the appropriate individual with the appropriate portion of the data. This field uses the composite ID and name (CNA) format described in 4.4.5.

TABLE 5-1 Value Types in Result Segments

Value Type	Meaning
NM	**Numeric**—single numbers; used for reporting quantitative results of a study such as velocities, amplitudes, and latencies.
ST	**String**—short text string; used for reporting noncoded nonnumeric results.
CE	**Coded entry**—coded data, including a code, description, and coding system identification; used for reporting qualitative test results (such as peak morphologies) or grading quantitative test results, and for reporting anatomic localizations, diagnostic impressions, medications, devices, special procedures, and recommended follow-up tests.
TX	**Text**—arbitrary length text data; used for reporting technical comments, descriptive reports, interpretations, and addenda.
CM	**Composite miscellaneous**—data with a defined format; used for reporting technical data, waveform digital data, annotations or analyses of waveform data, and test status and error data.
RP	**Reference Pointer**—specifies the location of actual waveform or other binary data on a remote system.

TABLE 5-2 Information Category Codes and Value Types

Result Segment Contents	Category	Value Type
Electrode definition data	ELC	CM
Montage definition data	MTG	CM
Channel definition data	CHN	CM
Time stamp and epoch/averaging data	TIM	CM
Waveform digital data	WAV	CM/RP
Anatomical distance data	DST	CM
Stimulus or calibration data	STM	CM
Technical comments	TCM	TX
Medications administered	MED	CE
Device or instrument used	DEV	CE
Device or instrument serial number	SER	ST
Special procedures/testing performed	CNP	CE
Annotations or analyses of waveform data	ANA	CM
Auxiliary montage selection	SEL	CM
Quantitative or qualitative single test results	...	NM/CE
Anatomic localization	ANT	CE
Diagnostic impression	IMP	CE
Descriptive report	GDT	TX
Interpretation	MDT	TX
Addenda to report	ADT	TX
Recommended follow-up tests	REC	CE
Error code and error message	ERR	CM
Active function status	STA	CM

TABLE 5-3 Abnormal/Change Codes in Result Segments

Value	Meaning
L	Below low normal
H	Above high normal
<	Below absolute low
>	Above absolute high
N	Normal
A	Abnormal (applies to non-numeric results)
—	(Not present) No ranges defined or normal ranges do not apply
U	Significant change up since last performance of test
D	Significant change down since last performance of test
B	Better (improvement) since last performance of test
W	Worse (deterioration) since last performance of test

TABLE 5-4 Codes for Nature of Abnormality Testing

Code	Meaning
A	An age-based population was tested
S	A sex-based population was tested
R	A race-based population was tested
N	None of the above (generic normal range)

TABLE 5-5 Result Status Codes

NOTE—Code priority (temporal order in which codes may replace one another) is as follows: X-D-I-S-R-P-F-U-C

Code	Meaning
R	Result entered, not verified (for example, only technician measured peak latency or amplitude, not physician-verified)
P	Preliminary result: a verified early result is available, final result not yet obtained (for example, resident, not staff, diagnosis)
F	Final result (complete and verified)
S	Partial result: some of this result has been entered, but some is still pending
C	Corrected: the result changes or corrects previous results with same test/observation ID, information category, and observation subID
X	Test or procedure could not be performed, order canceled
I	Test or procedure scheduled or in progress, results pending
D	Deleted: the previously transmitted or default result data of the same test/observation ID, information category, and observation subID is deleted (that is, marked *not present*; no new result sent)
U	Unchanged: the previously transmitted preliminary result data of the same test/observation ID, information category, and observation subID may be taken to be the final, verified result (which need not therefore be retransmitted in the result segment)

6. Result Segments Needed for Waveform Transmission/Display

6.1 These categories of result segments comprise the minimal subset required to define and transmit waveform data (Level I implementations). They would allow reconstruction, display, and minimal labeling of the waveforms; this is analogous to a recording on strip chart paper with only channel, sensitivity, and filter setting labels. The ELC, MTG, and CHN categories of result segments together define the information required to identify and label the waveform data or analyses made on that data. TIM category result segments define the time of the start of the epoch of waveform data which follows, the sampling interval of the waveform data, the epoch length, the transmitted data format, and waveform averaging information. WAV category result segments contain the actual waveform data or a pointer to the waveform data.

6.1.1 ELC category result segments define and name the electrodes or transducers attached to the subject and associate them with a physical amplifier input jack or pin number, when applicable. If only standard electrodes are used (for example, the standard 10-20 electrodes), no ELC category result segments need be transmitted; in this case, the receiving system either doesn't need to know the electrode or transducer characteristics, or uses a built-in set of default electrodes. Some studies (for example, polysomnograms) use special electrodes or transducers whose definition is critical for interpretation of the recording but for which no standards exist; for these studies, ELC category result segments should always be sent.

6.1.2 MTG category result segments define a named montage (an array of recording channels), while CHN category result segments define individual recording channels within a montage. These categories of result segment are required for all implementation levels. In a Level I implementation, only a single montage is available, and the MTG category result segment merely specifies the number of channels. In this case, ELC (if used) and then CHN category result segments are transmitted *after* the single MTG category result segment. CHN category result segments refer to electrode or transducer names defined in previously transmitted ELC category result segments (or to default electrode names when ELC category result segments are not used). TIM and WAV category result segments follow the ELC and the CHN category result segments. If electrode definitions change later in the recording, further ELC category result segments can be transmitted, which then apply to any subsequent WAV category result segments. Similarly, if channel settings change later in the recording, further CHN category result segments can be transmitted at any time to specify the new channel definitions.

6.1.3 In Level II and greater implementations, multiple montages may be available. Montages are identified by a number in the range one to *N*, where *N* is the maximum number of montages allowed by the transmitting (or data acquisition) and receiving (or display) systems. It is suggested that systems used for EEG be designed with a minimum *N* of ten.

6.1.4 In Level II and greater implementations, each montage has associated with it a set of electrode definitions (specified by ELC category result segments) and channel definitions (specified by CHN category result segments). The maximum number of each of these is also determined by the transmitting and receiving systems; for EEG systems, it is suggested that at least 40 electrodes or transducers and 32 channels be permitted. Whenever a MTG category result segment is received, the receiving system should respond by selecting that montage's electrode and channel definitions to be currently in effect (for interpreting subsequent waveform data transmissions). The number of channels in the montage (given in the MTG category result segment) determines the number of data values expected for each time sample in subsequent WAV category result segments. If the MTG category result segment received specifies a montage number which has not yet been used in the current study (that is, since the last OBR segment), an empty set of electrode and channel definitions is selected, which can be filled in by subsequently transmitted ELC and CHN category result segments. If the MTG category result segment specifies a previously used montage number, the previously defined electrode and channel definitions for that montage are put into effect. Thus, the order of result segment transmission used is generally MTG category followed by ELC category followed by CHN category.

6.1.5 A set of electrodes or transducers may also be defined which are *common*, that is, available to all montages. This is done by transmitting the ELC category result segments defining the common electrodes *prior* to the first transmitted MTG category result segment. As for simple one-montage implementations, receiving systems may have a default set of common electrodes (for example, the standard 10-20 or extended 10-20 system scalp electrodes) which can be modified or added to by any ELC category result segments that precede the first MTG category result segment. *Montage-specific* ELC category (and all CHN category) result segments are transmitted after the MTG category result segment to which they apply.

6.1.6 At least one MTG category result segment must be transmitted prior to any CHN, ANA, or WAV category result segments. Many applications will not require more than one MTG category result segment, since additions to or changes in channel or electrode definitions can be made at any time (by CHN or ELC category result segments) within the currently selected montage. However, the ability to store and later retrieve an entire montage definition may be useful for some systems. A set of defined, named montages may also be used by the receiving (or display) system for purposes in addition to interpreting the waveform data received; for example, some systems allow waveform data to be displayed using a montage other than that used to send the data, by means of a montage reformatting program. Whenever a MTG category result segment is transmitted, it not only selects the montage used for data transmission (either previously defined, or to be defined by subsequent ELC and CHN category result segments), but also usually causes the receiving system to select that same montage for other purposes (for example, display or printing). However, subsequent SEL category result segments (described in 7.10) may be transmitted to specify that different montages should be selected for functions other than data transmission (for example, display or printing).

ELC Category

6.2 This category of result segment defines electrodes (or other physiologic data transducers including SQUID magnetometers and gradiometers) by a name which may be referenced in subsequent ELC, CHN, or STM category result segments (which associate the electrodes or transducers with specific data channels or define them as being used for stimulation). Each electrode or transducer has a number (unique within a given montage, and generally the same as the physical amplifier input jack or pin number) and a unique alphanumeric name (used in subsequent ELC, CHN, or STM category result segments to identify the electrode, as well as in displays). Electrodes may be either *actual* or *derived*. An actual electrode is a physical electrode or a magnetometer or other transducer connected to an amplifier input, with a given location, attributes, and up to five coordinates that further specify its location and orientation. The optional coordinate data can be used for creating mapped displays, for source dipole and other spatial analysis programs, etc. A derived electrode is a fictitious electrode whose signal is calculated as a linear combination (a weighted sum) of the signals at one or more other, previously defined electrodes or transducers. An ELC category result segment may be followed by a comment (C) segment, if needed, to specify additional detail about the electrodes defined. Each ELC category result segment defines one or more electrodes or transducers, and any number of ELC category result segments may be used. The observation value field of this category of result segment contains one or more subfields separated by repeat delimiters (~). Each subfield defines one actual or derived electrode, and consists of multiple components.

6.2.1 *Defining Actual Electrodes/Transducers*—For defining an actual electrode or transducer, a subfield in the ELC category result segment consists of up to eight components separated by component delimiters (^). The format of the ELC category result segment used to define actual electrodes or transducers is summarized in Table 6-1. The individual components are defined as follows:

6.2.2 *Electrode Number and Name (both required)*—Identifies the electrode or transducer with a number and name. The alphanumeric name follows the number and is separated from it by a subcomponent delimiter (**&**). The maximum length of an electrode name is eight characters, but names longer than four characters should be avoided, if possible, because of space limitations in displays. The name **CAL** should not be used because it is reserved for use in CHN category result segments to indicate a calibration signal input.

6.2.3 *Electrode Location (optional)*—Specifies a general location for the electrode or transducer, which can be further qualified by specifying electrode coordinates if necessary. The electrode location field may not be present, in which case the value given for the previously defined electrode in the same ELC category result segment (if any) is used. No specific default applies if the location is not present in the first electrode definition in an ELC category result segment. The electrode location consists of up to six subcomponents separated from each other by subcomponent delimiters (**&**). The subcomponents of the electrode location are similar to the coded entry (CE) data type:

6.2.3.1 *Location Code 1*—An alphanumeric topography code from a generally accepted coding system which identifies the electrode or transducer location. The SNOMED universal topography code (extended by use of qualifiers when necessary) is the default coding system. Other coding systems beside SNOMED may be used, if available. Appendix X1 lists the SNOMED codes and qualifiers which are most likely to be useful in defining electrode or transducer locations. This table may be included in Level III implementations of the Technical Standard (in data acquisition systems, for example, as a menu from which the technician may select when defining new electrodes or transducers). In Level I and II implementations, the code could be directly entered by means of a keyboard (transmitting systems) or displayed without interpretation (receiving systems), or it may not be present (a less satisfactory alternative), with the electrode location instead specified in text form in the second subcomponent of the location field.

6.2.3.2 *Text for Location Code 1*—A text description of the topographic location identified by the alphanumeric code in the first subcomponent. It may be used to provide an annotated description of the code. Also, it may be used to identify a location that cannot be represented with a code or to provide added specificity to the code. In a Level III implementation of this Technical Standard, tables of text descriptions of each topographic code identified in the previous subcomponent are part of the receiving system software so that a standard code sent alone can be expanded to a full text description on displays or reports; such tables are not implemented in lower levels.

6.2.3.3 *Nature of Location Code 1*—Identifies the coding system used for the topographic code in the first subcomponent. Typical values are **SNM+** (SNOMED topographic codes and associated qualifiers as listed in Appendix X1) or **99zzz** or **L** (locally defined codes, where each *z* represents an alphanumeric character). The default is **SNM+**.

6.2.3.4 *Location Code 2*—This subcomponent contains any secondary alphanumeric code used to identify the topographic location.

6.2.3.5 *Text for Location Code 2*—This subcomponent contains a text description of the topographic location identified by location code 2.

6.2.3.6 *Nature of Location Code 2*—This subcomponent identifies the coding system used for location code 2 (the default is **L**, local codes).

6.2.3.7 *Usage of Locations and Coordinates*—When coordinates are *not* specified for electrodes or transducers, the location given may be as specific as desired. When coordinates *are* used, the topographic location need only specify the position of the origin of the coordinate system, since the individual coordinates specify the exact location of the electrodes. For example, the location of the vertex (**T-Y0120**) may be used as an origin for all scalp electrodes.

6.2.3.8 Table 6-2 shows example locations (using qualified SNOMED topographic codes) appropriate for defining some of the standard 10-20 system electrodes, plus two surface EMG electrodes used to record from the left triceps brachii muscle, two surface EKG electrodes on the chest, and a ground electrode. This level of specificity is not required; for many applications, it is sufficient to identify each 10-20 electrode simply as a scalp location (**T-Y0160**) without further qualifiers.

6.2.4 *Electrode/Transducer Attributes (optional)*—Defines electrode or transducer attributes. Any or all of these attributes may not be present, in which case the values given for the previously defined electrode in the same ELC category result segment are used. There are no defaults for the first electrode defined in an ELC category result segment. The attributes consist of multiple subcomponents separated from each other by subcomponent delimiters (**&**). These subcomponents are arranged in groups of four; each group defines the attributes of one of the elements making up the electrode (except that the first subcomponent, the electrode/transducer type, applies to all elements). Most electrodes and transducers have only one element. Multiple contact electrodes (such as concentric needle electrodes) and multiple loop magnetometers (magnetic field gradiometers) have multiple elements. The subcomponents defining electrode or transducer attributes are as follows:

6.2.4.1 *Electrode/Transducer Type*—Specifies the nature of the electrode or transducer. Any of the codes given in Table 6-3 may be used, or other codes may be used that have meaning to both the sending and receiving system.

6.2.4.2 *Material of Element 1*—For physical electrodes, specifies the material of which the first element or contact of the electrode is composed. For magnetometers and gradiometers, this refers to the material of which the first loop (closest to the subject) is composed. The material may be any of the codes in Table 6-4 or other chemical element symbols or more than one of these codes may be concatenated if the material is an alloy (for example, **AuPt** = gold-platinum combination); also, other codes may be used that have meaning to both the sending and receiving system.

6.2.4.3 *Diameter of Element 1*—Specifies the diameter in centimetres of the first element (contact or loop) of the electrode or transducer (a fraction, for example, 0.4, may be used).

6.2.4.4 *Polarity/Turns of Element 1*—For multicontact physical electrodes, this specifies whether the first contact is connected to the amplifier system in such a way that the signal is added (polarity = +1) or subtracted (polarity = -1). For example, for the center contact of a concentric needle electrode, polarity = 1 would be specified, but for the outer contact, polarity = -1 would be specified. This is only used when the concentric electrode is defined, for convenience, as a *single* electrode with two elements; it could alternatively be defined as two electrodes with one element each, in which case both electrode names would be specified separately in a CHN category result segment to indicate that one was connected to the first input and one to the second input of the differential amplifier. For multiple-loop gradiometers, this subcomponent specifies the number of turns in the loop. Positive numbers indicate counterclockwise loop polarity, while negative numbers indicate clockwise loop polarity. For example, a second-order gradiometer would have three loops, the first with polarity/turns = 1, the second with polarity/turns = -2, and the third with polarity/turns = 1.

6.2.4.5 *Distance Between Element 1 and 2*—For multicontact physical electrodes, this specifies the distance in centimetres (or fractions thereof) between the first and second electrode contacts. For multiple-loop magnetic gradiometers, this specifies the distance between the planes of the first and second loops in centimetres (the loops are all assumed to have the same orientation in space).

6.2.4.6 *Material of Element 2*—Specifies the material of which the second element (contact or loop) of the electrode or transducer is composed. The same codes are used as for element 1.

6.2.4.7 *Diameter of Element 2*—Specifies the diameter in centimetres of the second element (contact or loop) of the electrode or transducer.

6.2.4.8 *Polarity/Turns of Element 2*—Specifies the polarity and turns of the second element (contact or loop) of the electrode or transducer. The usage is the same as for element 1.

6.2.4.9 *Distance Between Element 2 and 3*—This specifies the distance in centimetres (or fractions thereof) between the second and third elements (contacts or loops) of the electrode or transducer.

6.2.4.10 *Material of Element 3*—Specifies the material of which the third element (contact or loop) of the electrode or transducer is composed. The same codes are used as for element 1.

6.2.4.11 *Diameter of Element 3*—Specifies the diameter in centimetres of the third element (contact or loop) of the electrode or transducer.

6.2.4.12 *Polarity/Turns of Element 3*—Specifies the polarity and turns of the third element (contact or loop) of the electrode or transducer. The usage is the same as for element 1.

6.2.4.13 *Additional Electrode/Transducer Attributes*—Subsequent subcomponents may be used in electrodes or transducers with more than three elements (contacts or loops) to specify, for each element in sequence, the distance between the previous and current element, the material of the element, the diameter of the element, and the polarity/turns of the element. Note that if a multiple-loop gradiometer is not composed of loops which all have the same orientation or otherwise cannot be defined properly by the conventions defined in 6.2.4.2 through 6.2.4.12, an alternative method is to define each loop as a separate transducer (*electrode*) with its own name, location, attributes, and coordinates, and then define a *derived* electrode which represents the appropriate linear combination (weighted sum) of the signals from each of the separate loops.

6.2.5 *Electrode Coordinate Number 1 (optional)*—Specifies a coordinate which identifies the location or orientation of the electrode or transducer relative to some origin and coordinate system. Coordinates are most useful for scalp, subdural, and cortical depth electrodes, and possibly other cephalic electrodes or transducers—locations where arrays of many electrodes are generally used. Coordinates may be used for other electrode or transducer locations also (for example, to identify different positions along a peripheral nerve or in a muscle). For multi-contact electrodes, the coordinates refer to the first contact (closest to the origin of the coordinate system). For magnetometers or gradiometers, the coordinates refer to the center point of the first loop (closest to the origin of the coordinate system). No default or previous values are used for coordinates which are not present.

6.2.5.1 A linear coordinate is defined along a particular axis, which has a direction in space and an origin (zero coordinate). An angular coordinate is defined with respect to a particular coordinate system (set of rectangular axes). When coordinates are supplied, the general electrode location given previously by means of a location code specifies the *origin* of the coordinate system, while the axis directions in space are specified with the coordinates. In general, three coordinates are necessary to specify a unique position, but for many purposes only two are needed (that is, if the electrode is assumed to be on the skin surface). In addition, for some transducers (for example, magnetometers and gradiometers) and for multi-contact linear electrodes, two additional angular coordinates may be used to specify an orientation of the electrode or transducer in space (for gradiometers with multiple loops, all loops are assumed to have the same orientation). Each coordinate consists of a number specifying a distance in centimetres or an angle in degrees, and a corresponding axis or angle identifier, separated by a subcomponent delimiter (**&**). The allowed axis or angle identifiers are given in Table 6-5.

6.2.5.2 The coordinate system recommended for all cephalic electrodes or transducers is either rectangular (*x* = distance left [-] or right [+], *y* = distance posterior [-] or anterior [+], *z* = distance inferior [-] or superior [+]), or spherical (*r*) = distance from origin radially outward, *th = longitude* or angle measured with respect to *z* axis, *ph = latitude* or angle of projection in *x*-*y* plane measured with respect to *x* axis). The orientation angles *th2* and *ph2* are used for transducers whose orientation must be specified (*th2* = angle measured with respect to *z* direction, *ph2* = angle of projection in *x-y* plane measured with respect to *x* direction). When the receiving system includes spatial mapping software, these coordinates can be used to produce a map, generally with *x* plotted horizontally and *y* vertically, or with *y* plotted horizontally and *z* vertically.

6.2.5.3 For two-dimensional rectangular coordinates (*x* and *y* only) used for scalp electrode arrays, the recommended origin is the vertex (general location **T-Y0120** using SNOMED codes). For three-dimensional rectangular coordinates and for spherical coordinates (which may be used for scalp, subdural, cortical depth, or other cephalic electrode arrays), the recommended origin is the center of the head (general location **T-Y0100** using SNOMED codes; for example, defined as the center of a sphere with radius and center coordinates chosen in such a way that it passes most nearly through the scalp electrodes). In this context, the spherical (angular) coordinate system allows electrode positions on the scalp surface to be specified using only two coordinates (*ph* and *th*) which are independent of head size, and it also lends itself more readily to dipole localization and other sophisticated processing of waveform data. Either rectangular (*x, y, z*) or cylindrical (*r, ph, z*) coordinate systems (with appropriate choice of origin) may be used for electrodes or transducers on the limbs or trunk, with the *z* axis often being equivalent to **IS** (trunk) or **PD** (limb).

6.2.6 *Additional Electrode Coordinates (optional)*—Subsequent components may be used to specify additional coordinates for the electrode or transducer. The format of each component is the same as for coordinate number one.

6.2.7 *Standard Electrode Names*—A system may have predefined defaults for the *common* electrode set (available to all montages), which may be supplemented or modified by ELC category result segments transmitted prior to the first MTG category result segment in Level II and higher implementations.

6.2.7.1 For EMG and NCS studies, where as few as two electrodes may routinely be used, the standard or default electrodes for the common electrode set might be, for example, the names G1 and G2 (referring to two electrodes used for surface recording, or to the two contacts on a bipolar or concentric needle electrode). Systems with multiple recording channels could define default electrode names G1, G2, G3, G4, etc.

6.2.7.2 The electrode names and approximate spherical coordinates associated with the extended 10-20 system of electrode nomenclature are listed in Table 6-6. These electrodes and coordinates (or, alternatively, the standard 10-20 system electrodes which are a subset of those listed in Table 6-6) might be the standard or default electrodes for the common electrode set for EEG, PSG, MSLT, and EP studies.

6.2.8 *Defining Derived Electrodes*—For defining a derived electrode, the subfield of the ELC category result segment consists of multiple components (up to a predefined limit, preferably 35 or more) separated by component delimiters (^). The format of the ELC category result segment that defines a derived electrode is given in Table 6-7. The individual components are defined as follows:

6.2.9 *Electrode Number and Name (required)*—Same as the first component used for defining an actual electrode.

6.2.10 *Electrode Location (optional)*—Same as the second component used for defining an actual electrode, but usually not present for derived electrodes.

6.2.11 *Derived Electrode/Transducer Type (required)*—Consists of the single keyword **DERIV** to indicate a derived electrode which is a linear combination of other electrodes.

6.2.12 *Electrode 1 Multiplier and Name (required)*—Identifies the first electrode to be included in the linear combination and the multiplier (weight) to be applied. The alphanumeric name follows the multiplier and is separated from it by a subcomponent delimiter (**&**).

6.2.13 *Additional Multipliers and Names*—Subsequent components identify the multipliers and names for additional electrodes to be included in the linear combination, using the same format. An example subfield defining a derived electrode is the following:

```
35&A12^^DERIV^0.5&A1^0.5&A2
```

This defines electrode A12 (electrode number 35) as the linear combination calculated as 0.5 times A1 plus 0.5 times A2 (that is, the average of A1 and A2).

MTG Category

6.3 This category of result segment selects or defines a named montage and specifies the number of channels in the montage. The observation value field of a MTG category result segment contains two components separated by component delimiters (^). The format of the MTG category result segment is summarized in Table 6-8. The individual components are defined as follows:

6.3.1 *Montage Number and Name*—Identifies the montage with a unique number and an optional name (used, for example, in displays). The name, if specified, follows the number and is separated from it by a subcomponent delimiter (**&**). It may contain alphanumeric and special characters (except delimiters).

6.3.2 *Maximum Number of Channels*—Specifies the number of channels in the montage (that is, the maximum number of data values at each time sample in subsequent WAV category result segments). It may not be present if the MTG category result segment specifies a previously used montage number, in which case the number of channels previously associated with that montage number is used.

CHN Category

6.4 This category of result segment defines a recording channel which is associated with one of the values in each time sample in subsequent WAV category result segments. Each channel has a number (which generally defines its position in a multichannel display) and an optional name (also used in displays). It usually has two associated electrodes (because of the use of differential amplifiers with two inputs), although when a multiple-element electrode or transducer is connected to the channel (for example, a special transducer such as a SQUID magnetometer or gradiometer with multiple coils, or an electrode with two or more contacts such as a concentric needle type), only one electrode name need be specified since the polarity and other attributes of each element (contact or coil) can be defined in the ELC category result segment. A channel also has an associated sensitivity, calibration parameters (sensitivity correction factor and baseline), time skew, sampling (digitization) frequency, minimum and maximum values, and any number of filter settings (up to the maximum allowed by the sending and receiving systems; this maximum should be at least three). Each CHN category result segment defines one or more channels, and any number of CHN category result segments may be used. A CHN category result segment may be followed by a comment (C) segment, if needed, to specify additional detail about the channels and their characteristics (for example, amplifiers and filters used, including detailed analog or digital filter characteristics). The observation value field of this category of result segment contains one or more subfields separated by repeat delimiters (~). Each subfield defines one channel, and consists of multiple components separated by component delimiters (^). The format of the CHN category result segment is summarized in Table 6-9. The individual components are defined as follows:

6.4.1 *Channel Number and Name*—Identifies the channel by number and name. The number is required, and must be in the range from one to *N* where *N* is the number of channels defined in the last MTG category result segment. The name is an optional text string containing alphanumeric characters; it is used in waveform data displays. If this name is not present, the channel label displayed is **<elec1>-<elec2>**, where <elec1> and <elec2> are the names of the two electrodes connected to this channel (if only one electrode or transducer is connected, the channel label displayed is the same as the electrode name). The maximum length of the channel name is 17 characters, but names longer than 9 characters should be avoided, if possible, because of limited space in displays.

6.4.2 *Electrode 1 and 2 Names*—Identifies the electrodes or transducers connected to the channel. The two names refer to electrodes defined in the montage (or electrodes common to all montages), and are separated by a subcomponent delimiter (**&**). The first name is required, but the second may not be present if the channel is connected to a special transducer or multi-element electrode or does not represent a differentially amplified signal with two inputs. Using **CAL** for the first (and only) electrode name indicates that the channel is connected to a calibration signal source (which may be further defined by a later STM category result segment).

6.4.3 *Channel Sensitivity and Units*—Defines the channel sensitivity and the units in which it is measured. This component consists of up to seven subcomponents, separated from each other by subcomponent delimiters (**&**). The first subcomponent specifies the sensitivity, while the remaining six subcomponents are used to specify the units of the sensitivity, using a format similar to the components of the coded entry (CE) data type. If the entire channel sensitivity and units component is not present, the value given for the previously defined channel in the same CHN category result segment is used; for the first defined channel in the segment, there is no specific default. The subcomponents of the channel sensitivity and units are as follows:

6.4.3.1 *Sensitivity*—Defines the nominal voltage (or other quantity for transducers other than voltage sensitive) corresponding to a value of one unit in the waveform data, that is, the effective resolution of the least significant bit of the ADC, and the polarity of the channel. The sensitivity incorporates both the amplifier gain and the actual ADC resolution. It does not, however, relate to the vertical scaling of a waveform display (that is, it is a measure of voltage, not voltage per unit distance). A positive sensitivity indicates that a positive number in the waveform data represents a potential at the first electrode which is more positive than that at the second electrode. A negative sensitivity indicates that a positive number in the waveform data corresponds to a potential at the first electrode which is more negative than that at the second electrode. The convention for many neurophysiologic studies is that positive potentials at the first electrode produce upward deflections; however, for EEG records the opposite is true.

6.4.3.2 *Units Code 1*—An alphanumeric units designation (for example, uv = microvolt, mv = millivolt, v = volt, or ft = femptotesla) from a designated system of units, such as ISO standard SI unit abbreviations (the default), or ANSI standard U.S. customary unit abbreviations.

6.4.3.3 *Text for Units Code 1*—An optional text description of the units identified by the first subcomponent. It may be used to provide an expanded description of the units abbreviation, or it may be used to identify units that cannot be represented with standard abbreviations.

6.4.3.4 *Nature of Units Code 1*—An identifier for the system of units used in the first subcomponent. Typical values are **ISO+** (SI units standard abbreviations, the default), **ANS+** (U.S. customary units standard abbreviations), or **99zzz** or **L** (locally defined units, where each *z* represents an alphanumeric character).

6.4.3.5 *Units Code 2*—An optional secondary alphanumeric units designation from an alternate system of units.

6.4.3.6 *Text for Units Code 2*—An optional text description of the secondary units designation in units code 2.

6.4.3.7 *Nature of Units Code 2*—An identifier for the alternate system of units used for units code 2 (the default is **L**, locally defined units).

6.4.4 *Channel Calibration Parameters*—This component consists of three optional subcomponents, separated from each other by subcomponent delimiters (**&**), which define corrections to channel sensitivity, baseline, and channel time skew which may be derived from a calibration procedure. If any of these subcomponents is not present, the corresponding value given for the previously defined channel in the same CHN category result segment is used; for the first defined channel in the segment, the defaults are used as listed in 6.4.4.1 through 6.4.4.3. The three subcomponents are as follows:

6.4.4.1 *Sensitivity Correction Factor*—Defines a correction factor for channel sensitivity which may be derived from the last calibration procedure performed. The actual channel sensitivity is the nominal channel sensitivity given in the previous component multiplied by the unitless correction factor. The default is one.

6.4.4.2 *Baseline*—Defines the actual channel baseline (the data value which corresponds to a nominal input signal of zero). The actual baseline may differ from the ideal because of a dc offset in the amplifier connected to the ADC. The actual baseline values for all channels (which need not be integers) may be determined at the time of calibration as the average digitized values obtained when a zero input signal is connected to each channel. The default is zero.

6.4.4.3 *Time Skew*—Defines the time difference between the nominal sampling (digitization) time (which would be the same for all channels) and the actual sampling time of the channel, in seconds (or fractions thereof). This value will differ from zero when all channels in the montage are not sampled simultaneously, as occurs in systems which sample successive channels at regular time intervals. This value may be determined from a calibration procedure in which an identical time-varying signal is applied to all channels and interchannel time differences are estimated, or more commonly it may be taken from the manufacturer's specifications for the digitizing system used. For example, for a system which samples successive channels at regular time intervals t, the time skew of channel number n would be $(n-1)t$. The actual time of sampling (digitization) of sample number m of channel number n in such a system would be $R + (m-1)/f + (n-1)t$, where R is the reference time at the start of the epoch specified in a TIM category result segment and f is the channel sampling frequency ($t < 1/f$). The default is zero.

6.4.5 *Channel Sampling Frequency*—Defines the sampling frequency in hertz of the channel (the reciprocal of the time in seconds between successive samples). This value may be zero to indicate that the channel is not sampled at regular intervals but rather is sampled sporadically; in this case, digitized values for the channel appear in waveform data only at those times when the channel is sampled, and are not present at all other times. In applications in which all channels in a given montage are sampled at the same frequency, the sampling intervals (reciprocal of the sampling frequency) for all channels are equal to the sampling interval for waveform data specified in later TIM category result segments that define the epochs of waveform data. In applications in which channels in a given montage are sampled at different frequencies, usually the sampling intervals of individual channels are integral multiples of the sampling interval specified in later TIM category result segments which define the epochs of waveform data, as described in 6.7 (waveform data acquired at differing sampling frequencies). If this is not the case, the *transmitting* system must convert the digitized data for each channel to effective values for a single sampling interval applicable to all channels for transmission; this practice should be used cautiously to avoid significant data distortion. If the channel sampling frequency is not present, the corresponding value given for the previously defined channel in the same CHN category result segment is used; for the first defined channel in the segment, no specific default value is assumed.

6.4.6 *Minimum and Maximum Data Values*—Defines the minimum and maximum data values which can occur in this channel in subsequent WAV category result segments, that is, the range of the ADC (a function of the number of bits in the ADC), and also specifies whether or not nonintegral data values may occur in this channel in subsequent WAV category result segments. If the minimum and maximum values are both integers (or not present), only integral data values may be used in this channel. If either the minimum or the maximum value contains a decimal point, then nonintegral as well as integral data values may be used in this channel (which is permissible only when waveform data values are transmitted in decimal format and which may require greater overhead in converting the waveform data values from decimal ASCII to an internal binary representation in the receiving system). Values outside of the specified range are flagged in subsequent WAV category result segments as overflow or underflow. For an n-bit signed ADC, the nominal baseline $B = 0$, and the minimum (L) and maximum (H) values may be calculated as follows:

$$L = -2^{n-1}$$
$$H = 2^{n-1} - 1$$

For an unsigned n-bit ADC, the minimum value $L = 0$, and the nominal baseline value (B) and maximum value (H) may be calculated from the formulas,

$$B = 2^{n-1}$$
$$H = 2^{n} - 1$$

6.4.6.1 The actual signal amplitude A (generally, the potential at electrode number one minus that at electrode number two) may be calculated from the data value D (range L to H) in the WAV category result segment using the actual baseline value B and the nominal sensitivity S and actual sensitivity correction factor C by the formula,

$$A = SC(D - B)$$

6.4.6.2 The minimum and maximum values are separated by component delimiters (**&**). If either of the values is not present, the corresponding value given for the previously defined channel in the same CHN category result segment is used; for the first defined channel in the segment, no specific defaults are used.

6.4.7 *Filter 1*—Defines the characteristics of the primary filter for the channel. The filter is specified in terms of its type (high pass, low pass, band pass, or band stop), implementation (analog or digital), low- and high-frequency limits, order, and other characteristics. This Technical Standard is based on the amplitude versus frequency response of the filter and does not describe directly the phase response. If it is necessary to specify more detail concerning the filtering process, a comment (C) segment following the CHN category result segment may be used (for example, one could specify the actual filter coefficients or algorithm for a digital filter).

6.4.7.1 The frequency response of a filter is characterized by passbands (ranges of frequencies in which the signal is not significantly attenuated) and stopbands (ranges of frequencies in which the signal is significantly attenuated). The description of the filter assumes a maximal gain of one in the passbands and specifies attenuations on a logarithmic scale with respect to this level as 0 dB. High- and low-frequency limits for an analog filter are specified at the 3-dB attenuation points (when the amplitude of a sine wave is attenuated to 70.7% of its unattenuated value), and high- and low-frequency rolloffs are specified in decibels per octave (10 dB representing a factor of ten change in amplitude, and one octave representing a factor of two change in frequency). A digital filter, which can have a more irregular frequency response curve with *ripple*, is characterized by a maximum attenuation in the passbands (representing the amount of *ripple* in the passbands) and by a minimum attenuation in the stopbands (that is, the attenuation in the stopbands is assumed to be always greater than or equal to this value). Between a passband and a stopband, there is a transition region, in which the attenuation changes continuously from the minimum stopband value to the maximum passband value or vice versa. The slope of the frequency response curve in each transition region is defined by giving the beginning and ending frequency of the transition band (that is, the frequencies adjacent to the passband and adjacent to the stopband).

6.4.7.2 Filter characteristics for a channel are assumed to relate to the sampling interval specified in the TIM category result segment that defines the epoch of digitized waveform data for that channel; as noted in 6.4.5, this sampling interval may differ from that implied by the actual channel sampling frequency as defined by the CHN category result segment. Therefore, if decimation filtering following higher frequency sampling or an operation such as ensemble averaging was performed, then the filter characteristics are reported as effective parameters after transformation from the original sampling frequency to the relevant sampling interval for the data as transmitted.

6.4.7.3 The filter 1 parameters consist of up to ten subcomponents, separated by subcomponent delimiters (**&**). If *all* of the filter 1 parameters are not present, all of the values given or assumed for the primary filter in the previously defined channel in the same CHN category result segment are used; if *all* are not present for the first channel in the segment, no primary filter is defined. The ten subcomponents are as follows:

6.4.7.4 *Filter Type (required)*—Defines the filter type. The codes given in Table 6-10 are used.

6.4.7.5 *Filter Implementation (required)*—Defines the implementation of the filter. The codes given in Table 6-11 are used.

6.4.7.6 *Filter Low-Frequency Limit (optional)*—For analog filters other than type **LP**, this defines the low-frequency limit of the filter in Hz (at 3-dB attenuation). For digital filters of type **HP** or **BP**, this defines the frequency in Hz at which the transition from stopband to passband begins (the frequency at which the amplitude is attenuated by an amount given by the minimum stopband attenuation specified by subcomponent nine). For digital filters of type **BS** (notch), this defines the frequency in Hz at which the transition from passband to stopband begins (the frequency at which the amplitude is attenuated by an amount given by the maximum passband attenuation specified by subcomponent ten). This subcomponent is not present for filters of type **LP**. There is no specific default; this subcomponent should be present when the filter type is **HP**, **BP**, or **BS**.

6.4.7.7 *Filter Low-Frequency Rolloff or Second Limit (optional)*—For analog filters other than type **LP**, this defines the low-frequency rolloff, that is, the slope of the logarithmic amplitude versus frequency curve at the low-frequency limit of the filter, in decibels per octave. For digital filters of type **HP** or **BP**, this defines the frequency in Hz at which the transition from stopband to passband ends (the frequency at which the amplitude is attenuated by an amount given by the maximum passband attenuation specified by subcomponent ten). For digital filters of type **BS** (notch), this defines the frequency in Hz at which the transition from passband to stopband ends (the frequency at which the amplitude is attenuated by an amount given by the minimum stopband attenuation specified by subcomponent nine). This subcomponent is not present for filters of type **LP**. There is no specific default.

6.4.7.8 *Filter High-Frequency Limit (optional)*—For analog filters other than type **HP**, this defines the high-frequency limit of the filter in Hz (at 3-dB attenuation). For digital filters of type **LP** or **BP**, this defines the frequency in Hz at which the transition from passband to stopband begins (the frequency at which the amplitude is attenuated by an amount given by the maximum passband attenuation specified by subcomponent ten). For digital filters of type **BS** (notch), this defines the frequency in Hz at which the transition from stopband to passband begins (the frequency at which the amplitude is attenuated by an amount given by the minimum stopband attenuation specified by subcomponent nine). This subcomponent is not present for filters of type **HP**. There is no specific default; this subcomponent should be present when the filter type is **LP**, **BP**, or **BS**.

6.4.7.9 *Filter High-Frequency Rolloff or Second Limit (optional)*—For analog filters other than type **HP**, this defines the high-frequency rolloff, that is, the slope of the logarithmic amplitude versus frequency curve at the high-frequency limit of the filter, in decibels per octave. For digital filters of type **LP** or **BP**, this defines the frequency in Hz at which the transition from passband to stopband ends (the frequency at which the amplitude is attenuated by an amount given by the minimum stopband attenuation specified by subcomponent nine). For digital filters of type **BS** (notch), this defines the frequency in Hz at which the transition from stopband to passband ends (the frequency at which the amplitude is attenuated by an amount given by the maximum passband attenuation specified by subcomponent ten). This subcomponent is not present for filters of type **HP**. There is no specific default.

6.4.7.10 *Filter Characteristics (optional)*—Defines the filter characteristics. The codes given in Table 6-12 may be used, or another code may be used which has meaning to both the sending and receiving systems; there is no specific default.

6.4.7.11 *Filter Order or Number of Coefficients (optional)*—For analog filters, this defines the order of the filter. For digital filters, this defines the total number of coefficients used in the filter. There is no specific default.

6.4.7.12 *Filter Minimum Stopband Attenuation (optional)*—For a digital filter, this defines the minimum attenuation in the stopband in dB, a measure of *ripple* in the stopband. The attenuation within the entire stopband is greater than or equal to this amount. This subcomponent has no meaning for analog filters. There is no specific default.

6.4.7.13 *Filter Maximum Passband Attenuation (optional)*—For a digital filter, this defines the maximum attenuation in the passband in dB, a measure of *ripple* in the passband. The attenuation within the entire passband is less than or equal to this amount. This subcomponent should not be present, or should be 3, for analog filters (for which a 3-dB attenuation is always used to define the frequency limits of the passband). There is no specific default for digital filters.

6.4.8 *Additional Filters*—Subsequent components may specify additional filters for the channel; the format of each is the same as for Filter 1. If *all* of the parameters defining an additional filter are not present, the values given for the corresponding filter in the previously defined channel in the same CHN category result segment are used; if *all* are not present for the first channel in the segment, no additional filter is defined.

6.4.8.1 An example subfield defining channel 15 as Fp1-F3 with sensitivity 0.5 μV (microvolts), sensitivity correction factor 1.1, baseline value 1, time skew 0.00031 s, sampling frequency 200 Hz, minimum and maximum data values -2048 and +2047, primary bandpass analog filter at 1 Hz (low) and 70 Hz (high) with 6-dB/octave rolloff, and an analog 60-Hz notch filter (filters from 51 to 67 Hz) with 12-dB/octave rolloff is as follows:

```
15^Fp1&F3^.5&uv^1.1&1&.00031^200^-2048&
2047^BP&ANA&1&6&70&6^BS&ANA&51&12&67&12
```

TIM Category

6.5 This category of result segment defines a time which characterizes the start of the epoch of waveform data which follows (WAV category result segments), or the start of an epoch in which an annotation, analysis, or feature detection has been applied, and which will be transmitted in the next ANA category result segment. It also determines the time which characterizes immediately following STM category result segments (defining the start or end of stimulation). It also defines the sampling interval (the time between successive digitized values for each channel in subsequent WAV category result segments), the transmission data format used, and optional parameters defining the epoch and averaging method for EP or other types of averaged data.

6.5.1 A TIM category result segment must be transmitted prior to any WAV, STM, or ANA category result segments. The receiving system should maintain a time variable which is initially loaded by the first TIM category result segment and is rewritten by each subsequent TIM category result segment. Each WAV category result segment causes the time variable to be incremented by an amount equal to the sampling interval multiplied by the number of time samples contained in or pointed to by the segment. STM, ANA, and other categories of result segment do not affect the time variable.

6.5.2 With this arrangement, many applications will not require more than one TIM category result segment, since the time variable is automatically updated as WAV category result segments are received. However, if there is a gap in the time sequence of waveform data (for example, a pause in the recording), this should be indicated by the transmission of a new TIM category result segment prior to subsequent WAV category result segments. A change in sampling interval or data format or beginning a new epoch for averaging or sleep stage scoring purposes would also require a new TIM category result segment. It may also be advantageous to transmit a new TIM category result segment preceding a new portion of a recording (for example, when the subject state changes from awake to asleep, or when beginning hyperventilation). Normally, the time variable increases during a transmission, but a TIM category result segment may set it back to a previous time in special circumstances. For example, if it is necessary to transmit both the *raw* unaveraged data for an EP study and the final average, a TIM category result segment could be transmitted to define the start time of the data acquisition, followed by the WAV category result segment(s) containing or pointing to all of the *raw* data, followed by another TIM category result segment to reset the time back to the initial start time and define an averaged epoch of data, followed by the WAV category result segment(s) containing or pointing to just the final averaged data.

6.5.3 The time which is defined by a TIM category result segment is an absolute time of day, rather than time relative to the start of the recording, and as such is transmitted as a date and a time (to facilitate prolonged recordings which continue through more than one day). The only exception is the special situation of downloading equipment settings by transmitting result (OBX) segments following the order (OBR) segment that is used to order the study. If time-dependent settings are downloaded, TIM category result segments may be transmitted, but the times that they specify are relative to the start of the procedure. For example, a stimulator program may be downloaded by transmitting a series of STM category result segments to define stimulus types, rates, durations, etc.; TIM category result segments immediately preceding each STM category result segment may be included to specify the times, relative to the start of execution of the stimulator program, at which each STM category result segment takes effect. An example of this usage is a photic stimulation program for EEG studies which specifies 1 Hz light flashes for 10 s at time 00:00:00, then 5 Hz light flashes for 10 s at time 00:00:15, then 8 Hz light flashes for 10 s at time 00:00:30, etc. (providing 5 s gaps between the end of each stimulus group and the beginning of the next).

6.5.4 The observation value field of a TIM category result segment contains up to nine components separated by component delimiters (^); its format is summarized in Table 6-13. The individual components are defined as follows:

6.5.5 *Time at Start of Epoch*—This component contains a date and time in the standard format described in 4.4.14 (with the time usually specified in seconds and fractions thereof, with a resolution equal to the sampling interval); Table 6-14 gives some examples. This component is required, except when the TIM category result segment is used only to download the sampling interval, epoch duration, transmitted data format, and averaging information as described in 9.4.4.7. When it is necessary to specify a time relative to the start of a procedure (as was described in 6.5.3) instead of an absolute time, the date portion of the time should be transmitted as 8 zero digits; for example, relative time 00:01:10 becomes 00000000000110.

6.5.6 *Sampling Interval*—This component specifies the time (in seconds) which elapses between samples in the digitized waveform data stream for any single channel (assumed to be the same for all channels in the current montage). For example, a typical value for EEG is 0.005.

6.5.7 *Duration of Epoch*—This component specifies the duration of the epoch of digitized waveform data which will follow, in seconds. The number of samples for each channel is the epoch duration divided by the sampling interval. This component is required when the waveform data represents an averaged set (an average of multiple fixed-length epochs), as for an EP recording. It also may be required for sleep stage scoring, in order to specify the duration of the epoch on which the scoring was performed. It is otherwise optional, for example for unaveraged EEG, EMG, or NCS data, since the transmitting system may not know the length of the following epoch until after it is transmitted.

6.5.8 *Transmitted Data Format*—This component indicates the format of the waveform data contained in or pointed to by all subsequent WAV category result segments (until the next TIM category result segment). Any of the codes given in Table 6-15 may be used. The default value is **DNC**. Although a particular transmitter system need only implement the data format(s) required for the type of waveform data it is designed to handle, the **DNC** data format will be the most commonly used, and will be implemented by most transmitter systems. All receiver systems must implement all of these standard formats. The **DEC** data format is only applicable to decimal waveform data and cannot be used for binary waveform data.

6.5.9 *Time from Reference Mark to Start of Epoch*—This value is required when defining an epoch of averaged waveform data; it is not present when defining an epoch of unaveraged data. It specifies the time in seconds from the reference point for averaging to the start of the epoch. The reference point is the time at which the stimulus is delivered for EP or NCS averaging, or the time of the external trigger for triggered averaging (for example, averaging of movement-related potentials triggered by a signal derived from the onset of a compound muscle action potential recorded by an EMG lead), or the time marked by a cursor in manual averaging of EEG, polysomnogram, or EMG transients (such as spikes), or the time marked by an automatic transient detection routine in automatic averaging of EEG, polysomnogram, or EMG transients. A positive number indicates that the averaging epoch begins some time *after* the reference time. A negative number indicates that the averaging epoch begins some time *before* the reference time (back averaging). In the latter case, the epoch may extend beyond the reference time if necessary (back and forward averaging). Zero indicates that the averaging epoch begins at the reference time.

6.5.10 *Averaging Method*—This optional component is used when defining an epoch of averaged data; it specifies the type of averaging performed on the waveform data in the epoch. Any of the codes given in Table 6-16 may be used, or other codes may be used that have meaning to both the sending and receiving system; there is no specific default. Averaging method **ALT** may be used, for example, for averaging evoked potential data resulting from alternating polarity auditory stimuli when it is desired to enhance the polarity-dependent waveforms (such as cochlear microphonics); it may also be used to obtain a *noise* epoch that can be compared with the *signal* epoch resulting from averaging all epochs in the standard fashion. Averaging method **CNT**, for example, may be used with n=2 to generate two averages simultaneously, with the first, third, etc., epochs forming one average, and the second, fourth, etc., forming the other. Averaging method **STM** is appropriate when multiple stimulus types are employed for evoked potential averaging (for example, an *oddball* stimulus paradigm in which unusual stimuli are intermixed randomly among a larger number of usual stimuli and an average is obtained of responses to unusual stimuli).

6.5.11 *Identification of Epochs Selected for Averaging*—This optional component is used only when defining an epoch of averaged data; it consists of two integer subcomponents (m and n) separated by a subcomponent delimiter (**&**) which identify the particular epochs included in the average for averaging methods **CNT**, **STM**, and **SEL**. For averaging method **CNT**, the epochs selected for averaging are those numbered m, $m + n$, $m + 2n$, etc. (for example, **2 & 5** indicates the second, seventh, twelfth, etc., epochs). For averaging method **STM**, the epochs selected for averaging are those evoked by stimulus type m out of a possible n stimulus types. The characteristics of each stimulus type are defined in a subsequent STM category result segment. For averaging method **SEL**, epochs selected for averaging are those satisfying criteria number m out of a set of n criteria. The actual criteria may be specified in an immediately following comment (C) segment if necessary.

6.5.12 *Number of Epochs Averaged*—This optional value, used for averaged data, specifies the number of epochs actually included in the average. There is no specific default.

6.5.13 *Number of Epochs Rejected*—This optional value, used for averaged data, specifies the number of epochs of *raw* data which were acquired but not included in the average because of artifact or for other reasons. There is no specific default.

WAV Category

6.6 This category of result segment is used to transmit the actual waveform data (the digitized values from an ADC or other digital data source) or a pointer to the waveform data (which uniquely identifies the location and length of waveform data). An epoch of waveform data for all channels and at multiple successive times may be contained in or pointed to by a single WAV category result segment (extended when necessary by use of addenda lines if the length exceeds the 220 character limit set by NCCLS LIS 5-A, and provided that the length of the observation value field does not exceed the maximum defined field length for OBX segments, 64K), or multiple successive WAV category result segments may be used, possibly with interspersed result segments of other types (for example, containing annotations or comments). The waveform data may be in either channel-multiplexed format (that is, the values for all channels for the first time sample are followed by the values for the next time sample, and so on until the end of the requisite number of time samples has been reached), or in channel block (unmultiplexed) format (that is, the values for the first channel for multiple time samples are followed by the values for the second channel for the same times, and so on until the end of all channels has been reached).

A transmitter system should transmit all data for a single electroneurophysiology study in either channel-multiplexed or channel block (unmultiplexed) format, and not employ a mixture of two formats. Furthermore, for those studies that involve acquiring multichannel waveform data continuously for seconds to hours (such as EEG, MEG, PSG, and continuous surface EMG recordings), channel-multiplexed format is to be the preferred format in order to allow receiver systems to handle sporadic annotations or montage changes that break the continuous stream of waveform data and are transmitted interspersed among blocks of waveform data. The preferred format for evoked potential studies is channel block (unmultiplexed).

The data may be contained within the WAV category result segment itself in the form of an array of decimal numbers as described in 6.6.1 and 6.6.2; this is most useful when the electrophysiologic study involves a smaller amount of waveform data. Alternatively, the waveform data in the form of an array of binary integers may be stored on another system or in a different file from the NCCLS LIS 5-A message itself, with the WAV category result segment containing a pointer to the location of the binary waveform data as described in 6.6.3; this is especially useful when the electrophysiologic study involves a large amount of waveform data. If one or more digitized values contained in or pointed to by the WAV category result segment were out of range of the ADC, then the entire result segment may optionally be flagged by inserting a < symbol (meaning values below the ADC range) or a > symbol (meaning values above the range) or both (separated by a component delimiter) into the abnormal flags field.

6.6.1 *Channel-Multiplexed Decimal Waveform Data Formats*—The observation value field of a standard WAV category result segment (with value type CM) that is used when the preceding TIM category result segment defining the epoch of waveform data specifies a data format of **DEC** or **DNC** contains one or more subfields separated by repeat delimiters (~). Each subfield contains data for multiple channels in the current montage at a single sample time. The subfield consists of multiple components separated by component delimiters (^), where each component contains the waveform data for a single channel. The format of the standard channel-multiplexed WAV category result segment is summarized in Table 6-17.

6.6.1.1 Each component consists of two subcomponents separated by subcomponent delimiters (**&**). The first subcomponent is the digitized value for a single channel at a single time; this may be either a signed decimal number (which may be nonintegral if a nonintegral minimum or maximum data value was specified in the CHN category result segment which defined this channel) or the special symbols < (meaning input to ADC was below its range) or > (meaning input to ADC was above its range). The second subcomponent is the channel number to which the digitized value applies. For a channel defined in the CHN category result segment with a nonzero sampling frequency, if the digitized value (first subcomponent) is not present, it is assumed not to have changed since the last time sample; this may be used to save space when digitized values for a particular channel remain constant over a number of time points (for example, a slowly varying signal such as from an oximeter). However, for a channel defined with a zero sampling frequency (implying sporadic rather than periodic sampling), if the digitized value is not present, then the channel is assumed not to have been resampled since the last time point. If the channel number (second subcomponent) is not present, then a channel number one greater than that of the previous component is assumed; for the first component, a channel number of one is assumed. If more than one digitized value for a particular channel is transmitted for a single time point, then the receiver system should use the last transmitted value for that channel. If a value for a channel number outside the range from one to *N* (where *N* is the number of channels specified in the last transmitted MTG category result segment) is transmitted, this value should be ignored by the receiver.

6.6.1.2 It is expected that most implementations will define channels within a montage in such a way that the digitized values for each time sample can be transmitted in ascending channel number order beginning with channel one. In this case, the second subcomponent (channel number) of each component in the WAV category result segment may not be present, since the first channel number defaults to one and each successive channel number defaults to one greater than the last. However, there may be some instances in which it is advantageous to transmit the channel values in a different order from that in which the channels are defined (or displayed), or the digitized values for a particular time point may be sufficiently sparse (due to the absence of values for a number of channels) that less characters are required to transmit a new channel number with each transmitted value than would be required to transmit the requisite number of *place-holding* component delimiters separating the values which are not present; in these instances the second subcomponent may be used to define the channel number as needed. For example, the following two result fields in a WAV category result segment are equivalent:

(1) `^^^219^^^^^^^^516^^^^^^^^^^^^^332^-414^28^12^^^^^^^^-1854`

(2) `219&4^516&12^332&25^-414^28^12^-1854&36`

6.6.1.3 The second subcomponent (channel number) is not permitted in WAV category result segments which follow a TIM category result segment that specifies a data format of **DNC**; in this situation, digitized values must be transmitted in ascending channel number order. To optimize performance, some receiver systems may use a different program to decode waveform data when **DNC** data format is used than for the **DEC** format.

6.6.1.4 Successive subfields in a WAV category result segment used for channel-multiplexed data transmission, if present, contain data for successive time samples, the time between corresponding channels in each (the sampling interval) having been specified in the last transmitted TIM category result segment.

6.6.2 *Channel Block Decimal Waveform Data Format*—The observation value field of a standard WAV category result segment (with value type CM) that is used when the preceding TIM category result segment defining the epoch of waveform data specifies a data format of **DCB** contains one or more subfields separated by repeat delimiters (~). Each subfield contains data for a single channel in the current montage at multiple sample times. The subfield consists of multiple components separated by component delimiters (^), where each component contains the waveform data for a single time sample. The format of the standard channel block (unmultiplexed) WAV category result segment is summarized in Table 6-18.

6.6.2.1 Each component contains the digitized value for a single channel at a single time; this may be either a signed decimal number or the special symbols < or > as described in 6.6.1.1. Successive components contain successive time samples, the time between each (the sampling interval) having been specified in the last transmitted TIM category result segment. For a channel defined in the CHN category result segment with a nonzero sampling frequency, if the digitized value is not present, it is assumed not to have changed since the last time sample. However, for a channel defined with a zero sampling frequency (implying sporadic rather than periodic sampling), if the digitized value is not present, then the channel is assumed not to have been resampled since the last time point.

6.6.2.2 Successive subfields in a WAV category result segment used for channel block (unmultiplexed) data transmission would contain data for successive channels in ascending channel number order. The first subfield determines the number of time samples being transmitted in the WAV category result segment; each subfield after the first normally contains the same number of components (same number of time samples) as the first. If fewer samples are transmitted in a subsequent subfield, the last transmitted value for that channel is assumed to be unchanged for the remaining time points (the last value is duplicated to pad the series to the correct length); if more samples are transmitted in a subsequent subfield, the excess are ignored. If a particular channel number in the range from one to *N* (where *N* is the number of channels specified in the last transmitted MTG category result segment) has not been defined by a previous CHN category result segment within the current montage, either a series of zero values (one for each time sample) would be transmitted in the subfield corresponding to that channel or the subfield as a whole would be not present; in either case, the channel when displayed should produce a flat line.

6.6.3 *Binary Data Format using Reference Pointer*—Rather than including decimally-encoded digital waveform data within the observation value field of one or more WAV category result segments, a pointer to an epoch of binary data may be given in the observation value field of a WAV category result segment, using the format described in 4.4.11,

```
<pointer>^<application ID>^<type of data>,
```

where **pointer** is a unique key assigned by the system that stores the data, **application ID** is a unique designator of the system on which the data is stored with three subcomponents, and **type of data** consists of **main type** and **subtype** subcomponents, which are codes representing the type of data being stored, as specified in Table 4-2. The format of the reference pointer WAV category result segment is summarized in Table 6-19. The preceding TIM category result segment would specify a data format of either **DNC** (for channel-multiplexed binary waveform data in ascending channel number order) or **DCB** (for channel block binary waveform data). Using **pointer**, the receiving system may obtain actual binary waveform data from the system named by **application ID** using file access or network protocols or other mechanisms outside the message scheme defined by NCCLS LIS 5-A and this Technical Standard. The binary data would consist of 8-bit or 16-bit signed integers. It is possible to use a nonstandard subtype (with a name beginning with the letter **Z** to distinguish it from the standard subtypes in Table 4-2) to allow a set of cooperating systems to use an NCCLS LIS 5-A formatted message to exchange data using a private (possibly proprietary) binary data format which does not conform to any of the formats defined by this Technical Standard. Such usages are entirely nonstandard and non-portable and no receiving system need be designed to accept data in other than the standard binary formats, in order to be considered compatible with this Technical Standard. The primary purpose of this mechanism would be to encourage evolutionary incorporation of this Technical Standard into existing designs, where internal formats are already established, or into time-critical applications in which the overhead of format conversion is unacceptable with current technology.

6.6.3.1 If the preceding TIM category result segment specified a data format of **DNC**, then the 8-bit or 16-bit words would be arranged in channel-multiplexed format. The first *m* words would be the values for channels 1 to *m* at the first time point (where *m* was defined in a preceding MTG category result segment), the next *m* words would be the values for channels 1 to *m* at the second time point, and so on, with the total number of time points *n* being calculated by the formula,

n = *byte-length* / (*word-length* * *m*)

where *byte-length*, which must be a multiple of *word-length* * *m*, is the value (**llll**) in the **pointer** component of the observation value field of the WAV category result segment, and *word-length* is 1 for 8-bit data subtypes or 2 for 16-bit data subtypes as determined by the **type of data** component.

6.6.3.2 If the preceding TIM category result segment specified a data format of **DCB** (channel block), then the 8-bit or 16-bit words would be arranged in channel block (unmultiplexed) format. The first *n* words would be the values for channel 1 at all *n* time points, the next *n* words would be the values for channel 2 at all *n* time points, etc., with the total number of channels *m* being defined in a preceding MTG category result segment, and with *n* calculated by the formula given in 6.6.3.1.

6.6.3.3 For both multiplexed and unmultiplexed subtypes, since the maximum byte-length is 2^{32}-1, for 16-bit data subtypes the maximum number of time points *n* in a block of binary data is 2,147,483,647/*m*. Very often the entire recording is divided into multiple separate blocks of waveform data. This may be done because the waveform data for the entire recording includes more than the maximum number of time points, because of the physical or logical characteristics of the storage media or file system used, because different channels are sampled at different sampling rates, or because of a need to change montages, redefine channels, define separate epochs of waveform data, or insert annotations or analyses that pertain to the waveform data. In such situations, successive WAV category result segments would be used, each specifying a pointer to a different block of waveform data. Interspersed among these WAV category result segments, there would be other result segments (such as MTG or SEL to change montages, CHN to redefine channels, TIM to define a new epoch and specify its starting time, ANA to define an annotation or set of analysis results). An example of this would be the multiple montage method of transmitting waveform data acquired at differing sampling frequencies (see 6.7.2). All of the blocks of waveform data could be stored in the same physical file, since each WAV category result segment defines a byte offset of the start of the waveform data within the file. Alternately, different blocks of waveform data could be kept in different physical files, since each WAV category result segment may include a file specification in the reference pointer. If stored in one physical file, the various blocks of waveform data need not be contiguous or even stored in sequential order. For example, the binary waveform data file could contain extra header sections of arbitrary byte-length preceding each block of waveform data that had a special use to the transmitting system that was beyond the scope of this Technical Standard. A receiving system that was compatible with this Technical Standard need not be aware of these header sections at all. However, a receiving system that was capable of reading and using these header sections could also be implemented. Such an implementation would require agreement between sender and receiver on the format, length, and meaning of the header sections, and is considered beyond the scope of this Technical Standard. For example, one possibility would be to include header sections in the binary data file formatted according to the European Data Format for EEG and polysomnographic data (**12**) or the European Data Format 'Plus' (**13**); if this were done, then the same binary data file could be read directly by receiver systems designed for EDF files *and* by receiver systems designed to read messages formatted according to this Technical Standard, provided that a suitably-formatted NCCLS LIS 5-A message were generated by the transmitting system which pointed to the binary data file.

6.6.3.4 When binary data is referenced by WAV category result segments using the RP value type, the information in these segments may be used by the receiver to generate an index of blocks of waveform data that could then be used for rapid, non-sequential access to the data. Such an index may be useful even if the waveform data referred to may not be available on the system receiving the NCCLS LIS 5-A formatted message or on the storage media containing the message, or if the waveform data may be available but access to it is not needed for certain applications (for example, applications in which mainly annotations, analyses, or reports derived from the waveform data are needed).

6.6.3.5 It is possible to mix epochs of binary waveform data with epochs of decimal-encoded waveform data in the same NCCLS LIS 5-A formatted message. This would be done by using CM value type in WAV category result segments that contain decimal-encoded waveform data, and using RP value type in WAV category result segments that point to blocks of binary data in a file.

Waveform Data Acquired at Differing Sampling Frequencies

6.7 This Technical Standard may be used to transmit waveform data recorded from various channels with differing sampling frequencies in one of two ways, described as follows.

6.7.1 *Highest Sampling Frequency Method*—Data may be encoded as if all channels were sampled at a single rate (specified in the TIM category result segment) which is in fact the highest sampling frequency in the set. However, a data value for channels sampled at a lower frequency (which must be an integral submultiple of the highest sampling frequency) would only be transmitted periodically at the appropriate sample times (that is, in every *n*th time sample in the WAV category result segment); values for all other time samples for that channel would not be present. Instead of values being not present, the digitized value at the previous sample time may instead be repeated for each subsequent time point in unsampled channels, until new data are available. When the **DNC** data format is used and data for unsampled channels at a given time point are not present, an efficiency can be realized if the lower frequency channel(s) are the highest numbered channel(s) in the channel list. In the time samples (subfields) for which an actual digitized value is not present, both the value(s) and component delimiter(s) for the lower frequency channel(s) may not be present if no other data follows them in that subfield. An alternative equivalent method of transmitting the data which is applicable only when the **DEC** data format is employed (best used when the number of channels sampled at a given time was small compared to the total number of channels in the montage) is to include only digitized values for those channels which were sampled, each followed by their channel number (separated by a subcomponent delimiter).

6.7.1.1 This mechanism is especially appropriate for data sets in which the majority of channels are sampled at the same highest frequency, with one or a small number of channels sampled at a lower frequency (which must be an integral submultiple of the highest sampling frequency). Table 6-21 shows an example of the digitized values and the times at which they were sampled for three channels, with channel 1 sampled at 100 Hz, channel 2 at 50 Hz, and channel 3 at 25 Hz.

6.7.1.2 In this example, the waveform data for the three channels would be transmitted using the **DEC** (or **DNC**) data format as follows, where the sampling interval specified in a preceding TIM category result segment is 0.01 s:

```
134^26^-18~142~153^20~150~139^15^-15~121~
114^9~109~98^4^-12
```

Similarly, the waveform data could be transmitted with the same sampling interval using the **DCB** data format as follows:

```
134^142^153^150^139^121^114^109^98~26^^
20^^15^^9^^4~-18^^^^-15^^^^-12
```

6.7.1.3 Unlike decimal waveform data contained within a WAV category result segment (in which unchanged data values for any channel may be omitted to save space in the message), every channel's data values for every time point are represented in the binary data file pointed to by a Reference Pointer in a WAV category result segment. Thus, when the highest sampling frequency method is used with binary data, the digitized value at a previous sample time must be repeated for each subsequent time point in unsampled channels until new data are available. The waveform data in Table 6-21 would appear in a binary data file as follows using a channel-multiplexed (DNC) format:

134	26	-18	142	26	-18	153	20	-18	150	20
	-18	139	15	-15	121	15	-15	114	9	-15
	109	9	-15	98	4	-12				

6.7.2 *Multiple Montage Method*—In situations in which the sampling frequency of some channels is not an integral submultiple of the sampling frequency of the other channels, epochs of data for each set of channels with differing sampling frequencies could be sent in separate WAV category result segments, each preceded by a MTG category result segment (to select the set of electrode and channel definitions appropriate for the subsequent WAV category result segment) and a TIM category result segment (to select the sampling interval appropriate for the subsequent WAV category result segment and to identify the time corresponding to the beginning of the epoch). The electrode and channel definitions for each montage (each set of channels sampled at a different rate) would have to be defined at the start of the recording by sending sets of MTG followed by ELC and CHN category result segments for each such montage (in Level II and higher implementations).

6.7.2.1 According to this scheme, a particular transmission may contain first a MTG category result segment, TIM category result segment, and all of the WAV category result segments for the entire recording corresponding to one sampling frequency, followed by a new MTG category result segment, TIM category result segment, and all of the WAV category result segments for another sampling frequency, etc. Alternatively, the transmission could be segmented into epochs of time, with a duration appropriate to the application (for example, the length of time that could be displayed on one screen of a display device or printed on one page of a printer). All of the data required for one epoch would be transmitted as a block, consisting of the MTG category result segment, the TIM category result segment, and one or more WAV category result segments for one sampling frequency, then new MTG, TIM, and WAV category result segments for the next sampling frequency, etc. The sequence would repeat for each epoch until all epochs were transmitted, maintaining the stream-oriented structure of the transmission.

6.7.2.2 Table 6-20 illustrates this method of transmitting waveform data; in this example of a 16-channel recording system, channels 1, 2, 3, and 8 are sampled at 100 Hz; channels 4 and 5 are sampled at 60 Hz; channels 6, 7, and 11 are sampled at 40 Hz; channels 9, 10, and 14 are sampled at 10 Hz; and channels 12, 13, 15, and 16 are unused.

TABLE 6-1 ELC Category Result Segment Format—Defining Actual Electrodes

Components of Result Field	Type	Max Length
Electrode Number and Name		
Electrode number	NM	4
Electrode name	ST	8
Electrode Location		
Location code 1	ST	80
Text for location code 1	ST	200
Nature of location code 1	ID	12
Location code 2	ST	80
Text for location code 2	ST	200
Nature of location code 2	ID	12
Electrode/Transducer Attributes		
Electrode/transducer type	ID	8
Material of element 1	ID	8
Diameter of element 1	NM	20
Polarity/turns of element 1	NM	20
Distance between element 1 and 2	NM	20
Material of element 2	ID	8
Diameter of element 2	NM	20
Polarity/turns of element 2	NM	20
Distance between element 2 and 3	NM	20
Material of element 3	ID	8
Diameter of element 3	NM	20
Polarity/turns of element 3	NM	20
. . .		
Electrode Coordinate Number 1		
Coordinate	NM	20
Axis or angle identifier	ID	8
Electrode Coordinate Number 2		
. . .		

TABLE 6-2 Example Electrode Location Definitions

Electrode	Location Identifier
Nz	T-12171-MID&Midline frontonasal suture (nasion)
Fp1	T-Y0111-LFT-ANT&Left anterior frontal region
F7	T-Y0111-LFT-LAT&Left lateral frontal region
F3	T-Y0111-LFT&Left frontal region
Fz	T-Y0111-MID&Midline frontal region
T7	T-Y0150-LFT&Left temporal region
T3	(synonym for T7)
C3	T-Y0120-LFT&Left vertex (central) region
Cz	T-Y0120-MID&Midline vertex (central) region
P7	T-Y0150-LFT-PST&Left posterior temporal region
T5	(synonym for P7)
P3	T-Y0130-LFT&Left parietal region
Pz	T-Y0130-MID&Midline parietal region
O1	T-Y0140-LFT&Left occipital region
Oz	T-Y0140-MID&Midline occipital region
A1	T-XY105-LFT&Left pinna of ear
T1	T-Y0150-LFT-ANT&Left anterior temporal region
Pg1	T-23000-LFT&Left nasopharynx
Sp1	T-10159-LFT&Left sphenoid bone
EMG1	T-13690-LFT-BEL&Left belly triceps brachii muscle
EMG2	T-13690-LFT-INS&Left insertion triceps brachii muscle
EKG1	T-11310-LFT-INF&Left inferior clavicle
EKG2	T-11310-RGT-INF&Right inferior clavicle
GND	T-10133-RGT&Right mastoid process of temporal bone

TABLE 6-3 Codes for Types of Electrode or Transducer

Code	Meaning
Electrodes or Special Transducers on or Near Subject	
DA	Self-adhesive disk electrode
DC	Disk electrode held with collodion
DF	Disk electrode held with paraffin
DP	Disk electrode held with paste
DS	Disk electrode held with suction
DT	Disk electrode held with tape
EC	Electrode mounted in cap
EG	Electrode mounted in rectangular grid or array
ES	Electrode mounted in linear strip
MC	Multicontact wire electrode for depth recording
WI	Thin wire electrode
HK	Hooked wire electrode
CL	Clip-on electrode
RI	Ring electrode
NE	Needle electrode, unspecified
NM	Needle electrode, monopolar
NB	Needle electrode, bipolar
NC	Needle electrode, concentric
NS	Needle electrode, EMG single fiber
NA	Needle electrode, macro EMG
MAG	Magnetometer or magnetic field gradiometer (SQUID device)
ACC	Accelerometer (motion detector; for example, piezoelectric crystal)
PRS	Pressure transducer (for example, arterial, venous, intracranial, esophageal)
STR	Strain gage (for example, thoracic, abdominal, or penile)
IMP	Impedance measuring device (for example, for impedance pneumogram)
IND	Inductance measuring device (for example, for inductive plethysmogram)
FLO	Flow-pressure transducer (for example, for pneumotachogram)
TMP	Thermometer (temperature sensor; for example, thermistor/thermocouple)
SND	Microphone (sound sensor; for example, laryngeal sound recorder)
HRT	Heart rate monitor (output proportional to average heart rate)
OXY	Oximeter (oxygen tension monitor)
CO2	Carbon dioxide tension monitor
PHM	pH monitor (for example, esophageal)
Signals from Other Devices (for example, used for stimulation)	
FLS	Flash stimulus monitor (for example, strobe light)
VIS	Other visual stimulus monitor (for example, pattern reversal occurrence)
AUD	Auditory stimulus monitor (for example, click or tone occurrence)
ELS	Electric stimulus monitor
SST	Somatosensory tester (signals stimulus such as percussion)
RST	Response tester (signals when subject or technician pushes button)
TIM	Time code or time marker

TABLE 6-4 Codes for Material for Physical Electrodes

Code	Meaning
Ag	Silver
AgCl	Silver chloride
Au	Gold
Cu	Copper
Nb	Niobium
Pt	Platinum
Sn	Tin
SS	Stainless steel

TABLE 6-5 Coordinate Axis or Angle Identifier Codes

Identifier	Meaning
IS	Axis running inferior to superior
SI	Axis running superior to inferior
LR	Axis running left to right
RL	Axis running right to left
ML	Axis running medial to lateral
LM	Axis running lateral to medial
PA	Axis running posterior to anterior
AP	Axis running anterior to posterior
PD	Axis running from proximal to distal
DP	Axis running from distal to proximal
DS	Axis running from depth to surface
SD	Axis running from surface to depth
X	X axis (LR for cephalic locations; $x = r \sin[\theta] \cos[\varphi]$)
Y	Y axis (PA for cephalic locations; $y = r \sin[\theta] \sin[\varphi]$)
Z	Z axis (IS for cephalic locations; $z = r \cos[\theta]$)
R	R axis (radial distance from origin; $r = \text{SQRT}\,[x^2 + y^2 + z^2]$)
TH	Angle theta with respect to [w.r.t.] z axis; $\theta = \arccos\,[z/r]$, range from 0 to 180
PH	Angle phi w.r.t. x axis; $\varphi = \arctan\,[y/x]$, range from 0 to 360
TH2	Orientation angle theta2 with respect to z direction
PH2	Orientation angle phi2 with respect to x direction

TABLE 6-6 Standard Electrodes and Spherical Coordinates

Electrode	Electrode Meanings	Theta, deg	Phi, deg	
Midline Electrodes				
Nz	Nasion	112.5	90	
Fpz	Frontopolar	90	90	
AFz	Anterior frontal	67.5	90	
Fz	Frontal	45	90	
FCz	Frontocentral	22.5	90	
Cz	Central	0	0	
CPz	Centroparietal	22.5	270	
Pz	Parietal	45	270	
POz	Parieto-occipital	67.5	270	
Oz	Occipital	90	270	
Iz	Inion	112.5	270	
10% Parasagittal Electrodes				
Fp1, Fp2	Frontopolar	90	108	72
F1, F2	Frontal	52.9	112	68
FC1, FC2	Frontocentral	33.4	132.7	47.3
C1, C2	Central	22.5	180	0
CP1, CP2	Centroparietal	33.4	227.3	312.7
P1, P2	Parietal	52.9	248	292
O1, O2	Occipital	90	252	288
20% Parasagittal Electrodes				
AF3, AF4	Anterior frontal	76.8	118	62
F3, F4	Frontal	64	129.1	50.9
FC3, FC4	Frontocentral	51.7	151.3	28.7
C3, C4	Central	45	180	0
CP3, CP4	Centroparietal	51.7	208.7	331.3
P3, P4	Parietal	64	230.9	309.1
PO3, PO4	Parieto-occipital	76.8	242	298
30% Parasagittal Electrodes				
F5, F6	Frontal	76.9	136.9	43.1
FC5, FC6	Frontocentral	71	157.9	22.1
C5, C6	Central	62.5	180	0
CP5, CP6	Centroparietal	71	202.1	337.9
P5, P6	Parietal	76.9	223.1	316.9
40% Parasagittal Electrodes				
AF7, AF8	Anterior frontal	90	126	54
F7, F8	Frontal	90	144	36
FT7, FT8	Frontotemporal	90	162	18
T3, T4	Temporal (T7, T8)	90	180	0
TP7, TP8	Temporoparietal	90	198	342
T5, T6	Posterior temporal (P7, P8)	90	216	324
PO7, PO8	Parieto-occipital	90	234	306
50% Parasagittal Electrodes				
F9, F10	Frontal	103.7	149.4	30.6
FT9, FT10	Frontotemporal	108.7	164.3	15.7
T9, T10	Temporal	112.5	180	0
TP9, TP10	Temporoparietal	108.7	195.7	344.3
P9, P10	Parietal	103.7	210.6	329.4
Other Electrodes				
A1, A2	Ears	120	180	0
T1, T2	Anterior temporal	106	162	18
Pg1, Pg2	Pharyngeal			
Sp1, Sp2	Sphenoidal			

TABLE 6-7 ELC Category Result Segment Format—Defining Derived Electrodes

Components of Result Field	Type	Max Length
Electrode Number and Name	*Same format as for defining actual electrode*	
Electrode Location	*Same format as for defining actual electrode*	
Derived Electrode/ Transducer		
Type	ID	8
Electrode 1 Multiplier and Name		
Multiplier	NM	20
Name	ST	8
Electrode 2, etc.		

TABLE 6-8 MTG Category Result Segment Format

Components of Result Field	Type	Max Length
Montage Number and Name		
Number	NM	4
Name	ST	40
Maximum Number of Channels	NM	4

TABLE 6-9 CHN Category Result Segment Format

Components of Result Field	Type	Max Length
Channel Number and Name		
Number	NM	4
Name	ST	17
Electrode 1 and 2 Names		
Electrode 1 name	ST	8
Electrode 2 name	ST	8
Channel Sensitivity and Units		
Sensitivity	NM	20
Units code 1	ST	80
Text for units code 1	ST	200
Nature of units code 1	ID	12
Units code 2	ST	80
Text for units code 2	ST	200
Nature of units code 2	ID	12
Channel Calibration Parameters		
Sensitivity correction factor	NM	20
Baseline	NM	20
Time skew	NM	20
Channel Sampling Frequency	**NM**	**20**
Minimum and Maximum Data Values		
Minimum	NM	20
Maximum	NM	20
Filter 1		
Filter type	ID	8
Filter implementation	ID	8
Filter low-frequency limit	NM	20
Filter low-frequency rolloff or 2nd limit	NM	20
Filter high-frequency limit	NM	20
Filter high-frequency rolloff or 2nd limit	NM	20
Filter characteristics	ID	8
Filter order or number of coefficients	NM	20
Filter minimum stopband attenuation	NM	20
Filter maximum passband attenuation	NM	20
Filter 2..n		

TABLE 6-10 Filter Type Codes

Code	Meaning
HP	High pass—removes frequencies below low-frequency limit
LFF	Low frequency filter. Synonym of the preferred term HP.
LLF	Low-frequency linear filter. Synonym of the preferred term HP. *Deprecated.due to inherent inaccuracy.*
LP	Low pass—removes frequencies above high-frequency limit
HFF	High frequency filter. Synonym of the preferred term LP.
HLF	High-frequency linear filter. Synonym of the preferred term LP. *Deprecated.due to inherent inaccuracy.*
BP	Band pass—removes frequencies outside low and high limits
BS	Band stop—removes frequencies between low and high limits

TABLE 6-11 Filter Implementation Codes

Code	Meaning
ANA	Analog filter
FIR	Digital filter, finite impulse response type
IIR	Digital filter, infinite impulse response type
LAT	Digital filter, lattice type
LAD	Digital filter, ladder type

TABLE 6-12 Filter Characteristics Codes

Code	Meaning
BAR	Bartlett filter
BES	Bessel filter
BLA	Blackman filter
BUT	Butterworth filter
CH1	Chebyshev 1 filter
CH2	Chebyshev 2 filter
COM	Comb filter
COS	Cosine taper filter
ELL	Elliptic filter
HAM	Hamming filter
HAN	von Hann filter
INT	Integrating filter
KAI	Kaiser filter
LER	Lerner filter
MOV	Moving average filter
ORM	Ormsby filter
TUK	Tukey taper filter

TABLE 6-13 TIM Category Result Segment Format

Components of Result Field	Type	Max Length
Time at Start of Epoch	TS	26
Sampling Interval	NM	20
Duration of Epoch	NM	20
Transmitted Data Format	ID	8
Time from Reference Mark to Start of Epoch	NM	20
Averaging Method	ID	8
Identification of Epochs Selected for Averaging (Epoch *m* of *n*)		
Integer *m*	NM	20
Integer *n*	NM	20
Number of Epochs Averaged	NM	20
Number of Epochs Rejected	NM	20

TABLE 6-14 Example Time Specifications

Date/Time	Interpretation
19900325153219.135	135 ms past 3:32:19 PM, March 25, 1990
19900802073512-05	7:35:12 AM EST (5 h behind Coordinated Universal Time), August 2, 1990
19901015134502.925	925 ms past 1:45:02 PM, October 15, 1990

TABLE 6-15 Transmitted Data Format Codes

Code	Meaning
DNC	Waveform Data with No Channel numbers (channel-multiplexed data transmitted in ascending channel number order) (**default**)
DEC	Waveform Data with Embedded Channel numbers (channel-multiplexed data with optional channel numbers in second subcomponent, not necessarily in ascending order)
DCB	Waveform Data in Channel Block (unmultiplexed format, transmitted in ascending channel number order)

TABLE 6-16 Averaging Method Codes

Code	Meaning
ALL	All epochs of data are included in the average
ALT	All epochs of data are included in the average, but successive epochs are alternately added to and subtracted from the average.
SEL	Epochs of data are included in the average only if they satisfy one of a number of different predefined selection criteria.
CNT	Epochs of data are counted and every *n*th epoch is included in the average where *n* is an integer number.
STM	Epochs of data to be included in the average are selected according to stimulus type.

TABLE 6-17 WAV Category Result Segment Format for Channel-Multiplexed Data

Components of Result Field	Type	Max Length
First Channel Data		
Digitized value	ST	20
Channel number	NM	4
Second Channel Data, etc. ...		

TABLE 6-18 WAV Category Result Segment Format for Channel Block Data

Components of Result Field	Type	Max Length
First Time Sample Digitized Value	ST	20
Second Time Sample Digitized Value	ST	20
. . .		

TABLE 6-19 WAV Category Result Segment Format for Binary (Reference Pointer) Data

Components of Result Field	Type	Max Length
Pointer	ST	384
Application ID		
Application identifier	ST	16
Universal ID	ST	256
Code	ID	8
Type of Data		
Main type	ID	12
Subtype	ID	16

TABLE 6-20 Example Segment Sequence Required to Transmit Waveform Data

Segment	Function
ELC-0	Define all electrodes common to all montages
MTG-1	Start definition of montage 1 (16 channels maximum)
ELC-1	Define all electrodes unique to montage 1
CHN-1	Define channels 1, 2, 3, and 8 in montage 1 (100 Hz rate)
MTG-2	Start definition of montage 2 (16 channels maximum)
ELC-2	Define all electrodes unique to montage 2
CHN-2	Define channels 4 and 5 in montage 2 (60 Hz rate)
MTG-3	Start definition of montage 3 (16 channels maximum)
ELC-3	Define all electrodes unique to montage 3
CHN-3	Define channels 6, 7, and 11 in montage 3 (40 Hz rate)
MTG-4	Start definition of montage 4 (16 channels maximum)
ELC-4	Define all electrodes unique to montage 4
CHN-4	Define channels 9, 10, and 14 in montage 4 (10 Hz rate)
MTG-1	Select montage 1 again
TIM-1,1	Set starting time of epoch 1, 1st sampling interval (0.01 s)
WAV-1,1	Waveform data for epoch 1, montage 1 (channels 1, 2, 3, 8)
MTG-2	Select montage 2 again
TIM-1,2	Set starting time of epoch 1, 2nd sampling interval (0.016667 s)
WAV-1,2	Waveform data for epoch 1, montage 2 (channels 4, 5)
MTG-3	Select montage 3 again
TIM-1,3	Set starting time of epoch 1, 3rd sampling interval (0.025 s)
WAV-1,3	Waveform data for epoch 1, montage 3 (channels 6, 7, 11)
MTG-4	Select montage 4 again
TIM-1,4	Set starting time of epoch 1, 4th sampling interval (0.1 s)
WAV-1,4	Waveform data for epoch 1, montage 4 (channels 9, 10, 14)
MTG-1	Select montage 1 again
TIM-2,1	Set starting time of epoch 2, 1st sampling interval (0.01 s)
WAV-2,1	Waveform data for epoch 2, montage 1 (channels 1, 2, 3, 8)
MTG-2	Select montage 2 again
TIM-2,2	Set starting time of epoch 2, 2nd sampling interval (0.016667 s)
WAV-2,2	Waveform data for epoch 2, montage 2 (channels 4, 5)
MTG-3	Select montage 3 again
TIM-2,3	Set starting time of epoch 2, 3rd sampling interval (0.025 s)
WAV-2,3	Waveform data for epoch 2, montage 3 (channels 6, 7, 11)
MTG-4	Select montage 4 again
TIM-2,4	Set starting time of epoch 2, 4th sampling interval (0.1 s)
WAV-2,4	Waveform data for epoch 2, montage 4 (channels 9, 10, 14)
(repeat for all epochs recorded)	

TABLE 6-21 Example Waveform Data for Channels Sampled at Different Rates

Channel 1		Channel 2		Channel 3	
Time	Data	Time	Data	Time	Data
0.00	134	0.00	26	0.00	-18
0.01	142	0.02	20	0.04	-15
0.02	153	0.04	15	0.08	-12
0.03	150	0.06	9		
0.04	139	0.08	4		
0.05	121				
0.06	114				
0.07	109				
0.08	98				

7. Result Segments Used for Annotation of the Waveform Data

7.1 These categories of result segments provide additional relevant information for interpretation of the electrophysiologic study. They do not specify the structure of the transmitted data, and so are not required in order to transmit waveforms for display, but they provide additional information which may be required to interpret the waveform data and draw relevant conclusions. These categories of result segments are not used in Level I implementations but are used in Levels II and greater.

DST Category

7.2 This category of result segment defines supplemental subject data related to the electrophysiologic procedure, consisting of distance measurements (generally made by a technician) needed for interpretation of the waveform data. Each DST category result segment can define one or more distances, and any number of DST category result segments may be used. The distances could be used for constructing potential maps, in source (dipole) localization programs, in calculating propagation velocities, etc. The observation value field of this category of result segment contains one or more subfields separated by repeat delimiters (~). Each subfield defines one distance measurement and consists of three components separated by component delimiters (^). The format of the DST category result segment is summarized in Table 7-1. The individual components are defined as follows:

7.2.1 *First Location Identifier*—Identifies the position of the first of the two locations between which the distance was measured. This location identifier has the same format as that used in the ELC category result segment for electrode locations. It consists of up to six subcomponents, separated by subcomponent delimiters (**&**). The first and fourth subcomponents are alphanumeric location codes, the second and fifth subcomponents are textual representations of the location, and the third and sixth subcomponents specify the coding system used in the first subcomponent (default **SNM+**, qualified SNOMED location codes) and fourth subcomponent (default **L**, local codes).

7.2.2 *Second Location Identifier*—Identifies the position of the second of the two locations between which the distance was measured, using the same format as the first location.

7.2.3 *Distance Value*—The measured distance in centimetres between the two locations on the subject's body.

7.2.4 Some examples of distance identifiers are given in Table 7-2.

7.2.5 It is suggested that, for routine EEG, polysomnogram, and EP recordings, the inion to nasion and left to right preauricular area distances be recorded by the technician and included in DST category result segments, since these numbers are routinely measured in placing electrodes according to the 10-20 system and are useful in calculating head radius (approximately, the geometric mean of the inion to nasion distance and the left to right preauricular area distance divided by 1.25π), which is needed to convert electrode angular (spherical) coordinates to rectangular coordinates and interelectrode distances.

STM Category

7.3 This category of result segment defines the stimulus parameters for an EP or NCS recording. It can also be used, if desired, to define stimulus parameters for photic stimulation or other regular stimuli or trains of periodic stimuli delivered during an EEG or similar recording. Furthermore, it can be used to indicate the type and amplitude of a calibration signal used during instrument calibration procedures. In addition, the occurrence of a STM category result segment at a particular time point in the series of WAV category result segments can be used to indicate that the stimulus or calibration signal occurred, began, or ended at that time. The time can be set, if necessary, by an immediately preceding TIM category result segment. A STM category result segment may be followed immediately by a comment (C) segment, if needed, to specify additional detail about the stimuli or stimulus paradigms used. When necessary, a single STM category result segment can define more than one simultaneously applied stimulus, or more than one STM category result segment can be used in immediate succession (for example, when continuous masking noise is applied to one ear and stimulus clicks to the other simultaneously, or when a stimulus paradigm employs more than one set of stimulus characteristics in a train of periodic or quasiperiodic stimuli). Multiple stimuli can be defined in a single STM category result segment either by specifying multiple stimulus characteristics (each in a separate subcomponent) within a single train of stimuli which are all of the same general type and all delivered to the same location, or by specifying multiple separate stimuli or trains of stimuli using separate subfields in the segment, or both. An individual stimulus type in such a segment may be referred to in TIM category result segments that define averaging by stimulus type by using a number specifying its ordinal position in the STM category result segment. The order used is: first subcomponent in first subfield, second subcomponent in first subfield, ..., last subcomponent in first subfield, first subcomponent in second subfield, second subcomponent in second subfield, ..., last subcomponent in last subfield. The observation value field of a STM category result segment contains one or more subfields separated by repeat delimiters (~). Each subfield defines one stimulus or train of related (but not necessarily identical, for example in a mixed stimulus paradigm) stimuli and consists of up to twelve components separated by component delimiters (^). The format of the STM category result segment is summarized in Table 7-3. The individual components are defined as follows:

7.3.1 *Stimulus Status*—This optional component may be used when a stimulus or train of periodic stimuli lasts for an extended period of time during which digital waveform data is accumulated. The stimulus status may be either **BEGIN** or **END**. The transmission of a STM category result segment with a **BEGIN** status at a particular time point in the series of WAV category result segments indicates that the stimulus or train of stimuli began at that time. Similarly, the transmission of a STM category result segment with an **END** status at a particular time point in the series of WAV category result segments indicates that the stimulus or train of stimuli ended at that time. It is not necessary to define the beginning and end of a train of stimuli by this method. In some applications, it may be more convenient to transmit a separate STM category result segment for each stimulus in the train. In the latter case, or for brief, nonrepetitive stimuli, the stimulus status component is not present; in this case, transmission of each STM category result segment at a particular time point in the series of WAV category result segments indicates that a single stimulus occurred at that time. It is not always necessary to indicate the time at which stimulation ended by means of a STM category result segment with status **END**; for example, the ending time of stimuli used in an EP recording is often irrelevant, since only averaged waveform data is usually transmitted, rather than continuous waveform data as in an EEG recording. Since it is possible to use multiple simultaneous stimuli, each of which may begin and end independently, all of the relevant components that characterize the stimulus should be repeated in the STM category result segment with an **END** status just as they were originally transmitted in the STM category result segment with a **BEGIN** status, so that the particular stimulus which ended can be uniquely determined.

7.3.2 *Stimulus Type and Electrode Names*—This required component specifies the type of stimulus and (for type **ELC**) the names of the electrodes stimulated. It consists of three subcomponents separated by subcomponent delimiters (**&**), as follows:

7.3.2.1 *Stimulus Type*—A code specifying the type of stimulus. The codes given in Table 7-4 or Table 7-5, or other codes having meaning to both the sending and receiving system, may be used. The difference between the **ECD** (or **ECP**) and **ELC** stimulus types is in the manner of specifying the stimulus electrode location. With **ECD** or **ECP**, a single location may be specified in the following component; with **ELC**, one may (in conjunction with an ELC category result segment) specify an electrode name, location, type, material, size, other attributes, and coordinates for both the cathode and anode.

7.3.2.2 *Cathodal Electrode Name*—This subcomponent is used when the first subcomponent is **ELC**. It specifies the name of the cathodal electrode through which the electric stimulus is delivered.

7.3.2.3 *Anodal Electrode Name*—This subcomponent is used when the first subcomponent is **ELC**. It specifies the name of the anodal electrode through which the electric stimulus is delivered. Both cathodal and anodal electrodes must have been previously defined in ELC category result segments, either in the current montage or in the group of electrodes common to all montages.

7.3.3 *Stimulus Location Identifier*—This optional component is used to specify the general location to which the stimulus was delivered. It is not needed for calibration signals (which are delivered to channels that use the electrode name **CAL**) or when a stimulus type of **ELC** is used (since the ELC category result segments specify electrode locations).

7.3.3.1 The stimulus location identifier has the same format as that used in the ELC category result segment for electrode locations. It consists of up to six optional subcomponents, separated by subcomponent delimiters (**&**). The first and fourth subcomponents are alphanumeric location codes, the second and fifth subcomponents are textual representations of the locations indicated by the first and fourth subcomponents, and the third and sixth subcomponents specify the coding system used in the first subcomponent (default **SNM+**, qualified SNOMED location codes) and the fourth subcomponent (default **L**, local codes). A SNOMED location code may contain additional qualifiers including **LFT**, **RGT**, or **BIL** designations when the stimulus is delivered exclusively to the left or right eye, ear, or body or bilaterally; if neither **LFT** or **RGT** designations appear (or if the location code is not present), the stimulus is assumed to be bilateral. Example SNOMED codes for stimulus location identifiers used for VEPs, AEPs, median nerve SEPs, tibial nerve SEPs, and ulnar nerve palmar orthodromic sensory NCS are given in Table 7-6.

7.3.4 *Stimulus Rate*—This optional component specifies the repetition rate of a repeated or periodic stimulus or calibration signal in hertz. For stimuli such as visual pattern reversals, light or pattern appearance/disappearance, or sinusoidally modulated pattern or light stimuli, the rate is best defined as the number of complete cycles (white to black to white) completed per second. For a square wave calibration signal, the rate is the number of on and off cycles per second. If the stimuli are generated pseudo-randomly rather than periodically, the stimulus rate refers to their average frequency of occurrence.

7.3.4.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by subcomponent delimiters (**&**). The first subcomponent specifies the repetition rate or average frequency of occurrence of the most common stimulus, the second subcomponent specifies the repetition rate or average frequency of occurrence of the next most common stimulus type, etc.

7.3.5 *Stimulus Duration*—This optional component specifies the duration of the stimulus or calibration signal in seconds, when applicable. For extended stimuli such as pattern reversal visual stimuli, the stimulus duration is one half the cycle period (the reciprocal of the stimulus rate), since each state of a pattern element (black or white) lasts for one half of a cycle. For square wave calibration pulses, the duration is also one half the cycle period (the length of an *on* or *off* period). For brief, repeated stimuli (such as light flashes, auditory clicks, electric stimuli), the duration of a single stimulus in the train is used, when known. For example, an electric stimulus duration might be 0.001. (The start and stop times of the entire train of stimuli may be specified as already described by the use of STM category result segments with status codes of **BEGIN** and **END**, respectively.)

7.3.5.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by subcomponent delimiters (**&**). The first subcomponent specifies the duration of the most common stimulus, the second subcomponent specifies the duration of the next most common stimulus type, etc.

7.3.6 *Stimulus Intensity*—This optional component specifies the intensity (average luminance, sound intensity, voltage, or current) of the stimuli or amplitude of the calibration signals in appropriate units (which may be specified in the following component).

7.3.6.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by subcomponent delimiters (**&**). The first subcomponent specifies the intensity of the most common stimulus, the second subcomponent specifies the intensity of the next most common stimulus type, etc.

7.3.7 *Stimulus Intensity Units*—This optional component specifies the units in which the stimulus intensity is measured. It consists of six subcomponents with a format similar to the components of the coded entry (CE) data type, as follows:

7.3.7.1 *Units Code 1*—An alphanumeric units designation from a generally accepted system of units, such as ISO standard SI unit abbreviations (the default), or ANSI standard U.S. customary unit abbreviations. Examples of ISO standard units include cd/m2 (candela per m^2) or cd/cm2 (candela per cm^2, also known as stilb) for visual stimuli, or cd.s/m2 (candela seconds per m^2) for brief (flash) visual stimuli; db, db(sl), db(hl), db(nhl), db(spl), or db(pespl) for auditory stimuli (the parentheses around the reference level designation are part of the units; the reference level designations are as follows: sl = sensory level, hl = hearing level, nhl = normal hearing level; spl = absolute reference sound pressure level of 20 micropascal at 1000 Hz; pespl = peak equivalent sound pressure level); v (volts) or ma (milliamperes) for electric stimuli; or uv (microvolts) or mv (millivolts) for calibration signals.

7.3.7.2 *Text for Units Code 1*—An optional text description of the units identified by the first subcomponent. It may be used to provide an expanded description of the units abbreviation, or it may be used to identify units that cannot be represented with standard abbreviations.

7.3.7.3 *Nature of Units Code 1*—An identifier for the system of units used in the first subcomponent. Typical values are **ISO+** (SI units standard abbreviations, the default), **ANS+** (U.S. customary units standard abbreviations), or **99zzz** or **L** (locally defined units, where each *z* represents an alphanumeric character).

7.3.7.4 *Units Code 2*—An optional secondary alphanumeric units designation from an alternate system of units.

7.3.7.5 *Text for Units Code 2*—An optional text description of the secondary units designation in Units Code 2.

7.3.7.6 *Nature of Units Code 2*—An identifier for the alternate system of units used for Units Code 2 (the default is **L**, locally defined units).

7.3.8 *Stimulus Frequency or Color*—For electric stimuli, this component specifies the frequency of the electric current in hertz (0 if dc current used). For auditory tone stimuli, this component specifies the frequency of the tone in hertz. For sine wave calibration signals, this component specifies the frequency of the signal in hertz. For visual stimuli, this component specifies the color of the stimulus. To specify color, a single code from Table 7-7 may be used (or other codes which have meaning to both the transmitting and the receiving system). Alternatively, the mixture of the primary colors RED, GREEN, and BLUE used may be specified as a comma-separated string of the form **REDrrr,GRNggg,BLUbbb**, where *rrr* (0-255) is the relative amount of red light, *ggg* is the relative amount of green light, and *bbb* is the relative amount of blue light in the stimulus. **WHT** is equivalent to **RED255,GRN255, BLU255**.

7.3.8.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by sub-component delimiters (**&**). The first subcomponent specifies the frequency or color of the most common stimulus, the second subcomponent specifies the frequency or color of the next most common stimulus type, etc.

7.3.9 *Visual Stimulus Contrast*—For visual pattern stimulus types, this optional component specifies the contrast of the pattern, defined as

$$\text{contrast} = \frac{L_{max} - L_{min}}{L_{max} + L_{min}},$$

where L_{max} is the luminance of the brightest elements of the pattern and L_{min} is the luminance of the darkest elements.

7.3.9.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by sub-component delimiters (**&**). The first subcomponent specifies the contrast of the most common stimulus, the second subcomponent specifies the contrast of the next most common stimulus type, etc.

7.3.10 *Visual Stimulus Pattern Type*—For visual pattern stimuli, this optional component specifies the type of pattern employed. Any of the codes in Table 7-8 may be used, or other codes which have meaning to both the transmitting and the receiving system; **CPX** indicates any pattern which cannot be described by one of the other codes.

7.3.10.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by sub-component delimiters (**&**). The first subcomponent specifies the pattern type of the most common stimulus, the second subcomponent specifies the pattern type of the next most common stimulus type, etc.

7.3.11 *Visual Stimulus Pattern Element Size or Spatial Period*—For visual pattern stimuli, this optional component specifies the size of the pattern elements (angle subtended by each at the actual viewing distance, in degrees) or their spatial period (total angle subtended by the pattern at the actual viewing distance in degrees divided by the number of cycles, bars, or elements across the pattern).

7.3.11.1 For mixed stimulus type paradigms employing a common stimulus type and one or more less common (*oddball*) stimuli types, this component may consist of two or more subcomponents separated by sub-component delimiters (**&**). The first subcomponent specifies the pattern size or spatial period of the most common stimulus, the second subcomponent specifies the pattern size or spatial period of the next most common stimulus type, etc.

7.3.12 *Size of Visual Field Stimulated*—For visual pattern stimulus types, this optional component specifies the size of the visual field stimulated in degrees, that is, the angle subtended by the entire pattern at the actual viewing distance.

TCM Category

7.4 This category of result segment is used to transmit a technical comment (often recorded by a technician) related to observations made by the technician or history obtained from the subject during the recording or technical aspects of the recording. In contrast to previous versions of this Technical Standard, the TCM category result segment does not pertain to and is not associated with the waveform data (instead, the ANA category result segment is used for all annotations to waveform data).

7.4.1 The text of the technical comment is contained in the observation value field of the TCM category result segment. Any length of text (up to 64K characters) may be included. Repeat delimiters (~) are used as line terminators. If multiple paragraphs are included in the comment, they should be separated from each other by two repeat delimiters (~~).

MED Category

7.5 This category of result segment defines a medication administered during or before the electrophysiologic study. In contrast to previous versions of this Technical Standard, the MED category result segment does not pertain to and is not associated with the waveform data (instead, the ANA category result segment is used for all annotations to waveform data).

7.5.1 The observation value field of this category of result segment contains a coded entry in the six-component format defined by the NCCLS LIS 5-A. The format of the MED category result segment is summarized in Table 7-9.

7.5.2 The first and fourth components could contain alphanumeric codes for a medication administered during or before an electrophysiologic recording. The second and fifth components would contain text defining the medication name, amount, and route of administration. The third and sixth components would contain an identification of the coding system used in the first and fourth components; there is no default for the third component, but a typical value is **W2**, the eight-digit World Health Organization record number drug codes **(9)**, while the default for the sixth component is **L**, local codes (several alternative coding systems for medications are defined in NCCLS LIS 5-A, which may be used if desired). If more than one medication is administered at the same time, each medication is transmitted in a separate MED category result segment.

DEV Category

7.6 This category of result segment defines the instrument (device) used to perform the electrophysiologic study. The observation value field of this category of result segment contains a coded entry in the six-component format defined by NCCLS LIS 5-A. The format of the DEV category result segment is summarized in Table 7-10. The first and fourth component could contain alphanumeric codes defining the instrument. The second and fifth components would contain text defining the instrument's manufacturer, model number, and software version (if applicable). The third and sixth components could contain an identification of the coding system used in the first and fourth components (there is no default for the third component; a typical value is **UMD**, the Universal Medical Device Nomenclature System **(10)**, that uniquely identifies a type of medical device but not its make or model; the default for the sixth component is **L**, local codes; **99zzz** may also be used to identify locally defined codes, where each *z* represents an alphanumeric character). If it is necessary to specify the serial number of the instrument as well, this information should be transmitted in a SER category result segment immediately following the DEV category result segment, as described in 7.7. If more than one device was used for the study, each device is transmitted in a separate DEV category result segment.

SER Category

7.7 This category of result segment defines the serial number of the instrument (device) used to perform the electrophysiologic study (specified in an immediately preceding DEV category result segment). The observation value field of this category of result segment contains a text string (value type ST) that defines the instrument's serial number. If more than one device is used for the study, so that more than one DEV category result segment is transmitted, each DEV category result segment is followed by a corresponding SER category result segment when it is necessary to specify the device serial numbers.

CNP Category

7.8 This category of result segment defines a special procedure or test performed during the electrophysiologic study. In effect, CNP category result segments can be used to summarize the testing that was performed. The observation value field of this category of result segment contains a coded entry in the six-component format defined by the NCCLS LIS 5-A standard. The format of the CNP category result segment is summarized in Table 7-11.

7.8.1 The first and fourth components would contain alphanumeric codes identifying the electrophysiologic studies performed, the second and fifth components would contain the corresponding text descriptions of the studies, and the third and sixth components could contain an identification of the coding system used in the first (a typical value is **AS4&TEST**, the test/observation ID codes defined in Appendix B) and fourth (the default is **L**, local codes) components. The intention of CNP category result segments is to indicate that certain subtests or activation procedures were performed that may not have been explicitly ordered. If more than one special procedure or test was performed during the study, each such procedure or test is transmitted in a separate CNP category result segment.

ANA Category

7.9 This category of result segment is used to transmit a textual annotation regarding the behavior of the subject or the status of the recording, or the results of analysis or processing of an epoch of waveform data. It is a multipurpose category, which can be thought of as a textual or quantitative annotation attached to an epoch of waveform data or to a single feature of the data, either in a single data channel, a range of consecutive channels, or all channels in a montage. It may be derived manually or by automated processing using a computer algorithm. Receiver system software may display the ANA results overlaid or side by side with the epoch or feature in the data channel or channels to which they apply. A variety of annotations or analyses can be performed on waveform data; the ANA category result segment is flexible enough to accommodate many of these. One use of the ANA category result segment is to transmit textual annotations (generated automatically or by a technician or physician) about the subject's observed behavior, actions taken by the technician during the recording, actions taken by the recording system (such as beginning or ending calibration mode), or general observations about the recording. Such annotations are typically not associated with any particular channel or channels or any specific montage, and apply to a specific point in time, not an epoch of waveform data.

7.9.1 Another use of the ANA category result segment is to mark or identify a feature in the waveform data. For example, for EPs, the feature identified is usually one of the recognized EP peaks. The ANA category result segment may be generated as a result of an automatic transient or peak detection program, or as a result of manually selecting a transient or peak. The marked feature is characterized by the channel number in which it was identified, by the algorithm used for its identification and the class or type of feature identified, and by various optional parameters characterizing the feature, such as one or more latencies relative to the start of the epoch, or one or more amplitudes or frequencies associated with the feature. The same feature is sometimes detected in more than one channel, simultaneously or with a small interchannel time difference, and this may result in the transmission of multiple ANA category result segments on some systems. For peaks in waveform data, the ANA category result segment data may include latencies and amplitudes in multiple channels, while the latencies and amplitudes reported in result segments with no information category code and with a value type of NM (the *final* values which would appear in the report) would generally be based on just one channel. A third possible use of the ANA category result segment is to transmit results of frequency spectral analysis of an epoch of waveform data. The spectrum data is characterized by the channel number from which it was derived, by the algorithm used for the calculation, and by various parameters which characterize the spectrum. The spectral parameters could be organized into named frequency ranges (for example, delta, theta, etc.) or into smaller frequency bins, and could include data such as power or amplitude and phase angles for each bin, or a peak frequency or mean frequency within a given frequency range.

7.9.2 An ANA category result segment either applies to the data at a specific point in time (zero duration or instantaneous annotation) or to an epoch of waveform data of nonzero duration. Usually, an ANA category result segment is transmitted just before or after its associated WAV category result segments, but it may occur at any point in the transmission. If needed, an ANA category result segment may be followed by a comment (C) segment to specify additional detail about the analysis.

7.9.3 The observation value field of the ANA category result segment contains multiple subfields separated by repeat delimiters (~). Each subfield defines one annotation or analysis and consists of a number of components separated by component delimiters (^). The format of the ANA category result segment is summarized in Table 7-12. The individual components are defined as follows:

7.9.4 *Annotation or Analysis*—This first component specifies the annotation or analysis attached to the waveform data. This component consists of nine optional subcomponents, separated from each other by subcomponent delimiters (**&**). If any of these subcomponents are not present, default values may be used. The nine subcomponents are as follows:

7.9.4.1 *Single or First Channel Number*—Identifies the one channel to which the annotation or analysis applies (for example, the channel in which a feature was detected) or the first channel of a range of contiguous channels to which the annotation or analysis applies. If not present, a value of 0 is assumed, which indicates that the annotation or analysis applies simultaneously (within one sampling interval) to all channels. This channel number, as well as the last channel number in subcomponent 4, are assumed to be channels within the montage specified by subcomponent 5. For annotations which are not specific to a particular montage or set of channels, this subcomponent should be not present.

7.9.4.2 *Annotation Source or Algorithm Name*—Identifies the source of the annotation (for example, a technician or physician) or the method or algorithm used for the analysis (for example, the method used for feature detection). One of the standard source or algorithm names may be used, or a nonstandard name may be used if it has meaning to both the sending and receiving system (for example, the name **SPSZDT-XYZ** could be used to identify a particular spike and seizure detection algorithm identified by **XYZ**). If not present, the value for this subcomponent in the previous annotation or analysis (previous subfield) in the ANA category result segment is assumed; for the first annotation or analysis, **MAN** (manual annotation at the time of data acquisition) is assumed. The standard source or algorithm names are given in Table 7-13.

7.9.4.3 *Annotation or Analysis Type*—This subcomponent further identifies the type of annotation, analysis, or detected feature. For example, for the annotation sources **MAN**, **MACH**, **TECH**, or **PHYS**, certain standard annotations which are used frequently during EEG and polysomnogram recordings may be transmitted using the annotation type codes and annotation text (for English-speaking countries) given in Table 7-14. The abbreviated annotation text in the table is suggested, not required by this Technical Standard. A code other than those in the table may be used if it has meaning to both sending and receiving systems. On some data acquisition systems, standard annotations such as these (except the last two) may be generated automatically by simply pressing an appropriate key typed on a keyboard. One advantage of having a single key generate comments such as *eyes open*, *eyes closed*, *awake*, *drowsy*, *asleep*, *comatose*, *begin HV*, *begin photic*, *begin medication*, *begin seizure*, and *begin <other special recording condition>* is that the same key can also trigger a change in the test/observation ID (see Appendix B) in subsequent result segments to reflect the new recording condition. For analysis algorithms **TECH**, **PHYS**, **AUTO**, **PEAK**, **SPSZDT**, and others that can perform more than one type of analysis or can detect more than one feature, the annotation or analysis type specifies the type of analysis performed or identifies the feature detected. One of the codes listed in Table 7-17 may be used, or a name other than those may be used if it has meaning to both sending and receiving systems (for example, many laboratories will define multiple additional EEG/polysomnogram features besides those given in the Table which may be used for annotation of waveform data). If the annotation or analysis type is not present, the value for this subcomponent in the previous annotation or analysis (previous subfield) in the ANA category result segment is assumed; no default is assumed for the first annotation or analysis.

7.9.4.4 *Last Channel Number*—Identifies the last channel of a range of contiguous channels to which the annotation or analysis applies. If not present, the annotation or analysis is assumed to apply to only the single channel given in subcomponent 1, or to all channels if subcomponent 1 is not present or zero. This channel number, as well as the first channel number in subcomponent 1, are assumed to be channels within the montage specified by subcomponent 5, and the last channel number should be greater than or equal to the first channel number. For annotations which are not specific to a particular montage or set of channels, this subcomponent should be not present.

7.9.4.5 *Montage number*—Identifies the montage to which the annotation or analysis applies. The montage should have been previously defined in a MTG category result segment. If not present, the current data transmission montage specified in the last transmitted MTG category result segment is assumed. For annotations which are not specific to a particular montage, this subcomponent should be not present.

7.9.4.6 *Annotation text*—Specifies a text annotation for the waveform data, or a text description of the analysis performed or feature detected. This text may be a description of the annotation or analysis type code, or it may be used to identify and describe an annotation that the sender cannot represent with one of the standard annotation or analysis type codes. If the annotation text is not present, the value for this subcomponent in the previous annotation or analysis (previous subfield) in the ANA category result segment is assumed; no default is assumed for the first annotation or analysis.

7.9.4.7 *Date/time of annotation or analyzed data*—Defines a time which characterizes the annotation or the start of the data analyzed or the feature detected. For annotations or features which have a finite nonzero duration, this subcomponent specifies the start of the feature and the next subcomponent specifies its duration. For analyses that involve an epoch of waveform data (for example, frequency spectral analysis), this subcomponent specifies the start of the epoch of data analyzed and the next subcomponent specifies its duration. If this subcomponent is not present, the value for this subcomponent in the previous annotation or analysis (previous subfield) in the ANA category result segment is assumed; if this subcomponent is not present in the first annotation or analysis, no default is assumed; instead, the annotation or analysis is assumed to begin at the current time (the time determined by the last transmitted TIM category result segment as updated by subsequent WAV category result segments).

7.9.4.8 *Duration of annotation or analyzed data*—Defines the duration of the annotation or feature detected or of the epoch of data analyzed, in seconds. If this subcomponent is not present, the value for this subcomponent in the previous annotation or analysis (previous subfield) in the ANA category result segment is assumed; if this subcomponent is not present in the first annotation or analysis, zero is assumed.

7.9.4.9 *Date/time annotation or analysis performed*—Identifies the date and time at which the annotation was generated or the analysis was performed. In general, this is not the same as the date/time of the waveform data to which the annotation or analysis applies. If this subcomponent is not present, the value for this subcomponent in the previous annotation or analysis (previous subfield) in the ANA category result segment is assumed; if this subcomponent is not present in the first annotation or analysis, no default value is assumed.

7.9.5 *Analysis Parameters*—The remaining optional components represent parameters derived from the annotation, analysis, feature detection, or cursoring routine, such as durations, amplitudes, latencies, times from onset to peak, frequencies, powers, phase angles, etc. The number of parameters (up to a system-imposed limit, preferably at least 200) and their nature depend entirely on the annotation source or algorithm name and the annotation or analysis type. Each parameter has up to eight subcomponents separated from each other by subcomponent delimiters (**&**).

7.9.5.1 *Parameter Value (required)*—The value of the parameter (a decimal number or text string).

7.9.5.2 *Parameter Name (optional)*—The name or identity of the parameter resulting from waveform analysis. If the name is not present for the *n*th entry in the parameter list for the annotation or analysis, then it is assumed to be the same as that of the *n*th entry in the parameter list for the *previous* annotation or analysis (previous subfield) specified in the same ANA category result segment. If the name is not present for the *n*th parameter in the *first* annotation or analysis in the ANA category result segment, no specific default name is assumed. The parameter name may be one of the standard names given in Table 7-17, or another name may be used which has meaning to both the sending and receiving systems.

7.9.5.3 *Units Code 1 (optional)*—An alphanumeric designation which specifies the units in which the parameter is measured (such as uv = microvolt, mv = millivolt, ms = millisecond, hz = hertz, uv2 = microvolt squared), taken from a generally accepted system of units, such as ISO standard SI unit abbreviations (the default) or ANSI standard U.S. customary unit abbreviations.

7.9.5.4 *Text for Units Code 1 (optional)*—A text description of the units identified by the first subcomponent. It may be used to provide an expanded description of the units abbreviation, or it may be used to identify units that cannot be represented with standard abbreviations.

7.9.5.5 *Nature of Units Code 1 (optional)*—An identifier for the system of units used for units code 1. Typical values are **ISO+** (SI units standard abbreviations, the default), **ANS+** (U.S. customary units standard abbreviations), or **99zzz** or **L** (locally defined units, where each *z* represents an alphanumeric character).

7.9.5.6 *Units Code 2 (optional)*—A secondary alphanumeric units designation from an alternate system of units.

7.9.5.7 *Text for Units Code 2 (optional)*—A text description of the secondary units designation in units code 2.

7.9.5.8 *Nature of Units Code 2 (optional)*—An identifier for the alternate system of units used for units code 2 (the default is **L**, locally defined units).

7.9.5.9 If the six subcomponents defining units are not present, the units for the *n*th entry in the parameter list for the annotation or analysis are assumed to be the same as those of the *n*th entry in the parameter list for the *previous* annotation or analysis (previous subfield) specified in the same ANA category result segment. If they are not present for the *n*th parameter in the *first* annotation or analysis in the ANA category result segment, then parameters defining durations, latencies, or times are expressed as multiples of the sampling interval, and parameters defining amplitudes are expressed as multiples of the channel sensitivity, while no specific default units are assumed for other parameters.

7.9.6 Examples of annotation or analysis type codes and associated parameter names which are likely to be of general applicability are given in Table 7-17; if these standard type codes and names are used, their meaning should be as indicated in this table. As noted, other codes and names may be used if their meaning is mutually agreed upon by the transmitting and receiving systems. Not all of the listed parameters for a given analysis or feature type need be determined in any given implementation of an analysis algorithm; similarly, not all possible parameters are listed for a given analysis or feature type. Note that parameters describing latencies (such as PKLA or ONLA) refer to the time interval between the date/time of the annotation or analyzed data specified in the first component and the peak or onset of the detected waveform or feature. If the date/time of the annotation or analyzed data was not specified in the first component (and no default was assumed), then the current time (the date/time specified in the last transmitted TIM category result segment as updated by subsequent WAV category result segments) is used as a baseline for latency measurements.

SEL Category

7.10 This category of result segment indicates selection of particular montages for specific functions in the receiving system. Whereas the MTG category result segment selects the montage that is currently being used for data transmission (that is, the montage which describes the format of the data in subsequent WAV category result segments), the SEL category result segment selects *auxiliary* montages (montages used for other than data transmission). Receiver systems that implement montage reformatting capabilities may (if desired) respond to a SEL category result segment by enabling reformatting of the incoming waveform data to different montages prior to display, printing, analysis, event detection, storage, etc. (the montages used for these purposes may alternatively be selected by the receiver system). If desired, the receiver system may also start (or stop) the indicated functions (such as waveform printing) when a SEL category result segment is received. Receiver systems that have no montage reformatting capabilities may ignore the SEL category result segment and interpret or display the waveform data according to the format indicated in the last MTG category result segment. Use of the SEL category result segment is optional; it need only be implemented in those transmitting systems that need the capability of informing the receiving system of a change in auxiliary montages. The receiver system is responsible for verifying that the montages requested in a SEL category result segment can in fact be reconstructed by appropriate manipulation of the montage used for data transmission; usually, this will only be possible if the data transmission montage uses a single common reference electrode in all or most of the channels, and if the channel sensitivity and units, sampling frequency, and filters are identical for all of the channels that use the common reference electrode. The receiver system remontaging software is also responsible for determining the appropriate algorithm needed to convert the incoming data montage to the requested montages for the auxiliary functions.

7.10.1 All montages must be defined before use by transmitting MTG, ELC, and CHN category result segments as described in Section 6. The last MTG category result segment transmitted selects the montage used for data transmission. Receiver systems will also usually use this montage initially for all auxiliary functions (waveform display, printing, storage, etc.). When a subsequent SEL category result segment changes the montages used for particular functions (such as display), the new montages remain in effect for these functions until either another SEL category result segment specifying one or more of the same functions is received (which affects only the montages for the functions specified), or another MTG, ELC, or CHN category result segment is received (which changes or modifies the montage used for all auxiliary functions as well as the montage describing the transmitted data). In effect, any new CHN or ELC category result segments are interpreted as modifications to the currently selected data transmission montage (the one specified in the last transmitted MTG category result segment), and the receiving system will change the montages used for all auxiliary functions to the current data transmission montage just as if a new MTG category result segment had been transmitted. This ensures that the receiving system will not continue to use a previously constructed remontaging algorithm when the format of the incoming data changes because of adding, deleting, or modifying channels or electrodes. If it is desired to transmit a change affecting only a montage used for an auxiliary function (such as display), without changing the current data transmission montage, this can be accomplished by first sending a MTG category result segment to select the montage to be changed, then sending one or more ELC or CHN category result segments to change the characteristics of that montage (such as sensitivities, filter settings, etc.), then sending a MTG category result segment to reselect the appropriate data transmission montage, then sending a SEL category result segment to reselect the appropriate auxiliary montages.

7.10.2 The observation value field of a SEL category result segment contains one or more subfields separated by repeat delimiters (~). Each subfield associates one montage with one function, and consists of two components separated by component delimiters (^). The format of the SEL category result segment is summarized in Table 7-15. The individual components are defined as follows:

7.10.3 *Montage Number (optional)*—Identifies the montage to be selected for a particular function by its number; this montage number must have been defined in a previously transmitted MTG category result segment. If the montage number is not present, the effect is to deselect the montage previously selected for the particular function without selecting a new montage. Depending on the receiver system implementation, this may either cause the receiving system to revert to using the transmitted data montage (without reformatting) for the specified function, or may tell the receiving system to stop the specified function (for example, waveform printing).

7.10.4 *Montage Function (required)*—Identifies the function for which the specified montage will be used by the receiving system. The allowed functions are listed in Table 7-16; alternatively, other function identifiers may be used that have meaning to both the sending and receiving system. A receiving system need only implement those functions which it needs; it may ignore any other functions used in SEL category result segments.

7.10.5 Table 7-18 shows an example of the sequence of MTG, CHN, ELC, and SEL category result segments needed to define four montages, select one of these for waveform data transmission, and select the others in turn for waveform display and printing. In this particular implementation, selecting or deselecting a montage used for printing or display also causes the receiving system to begin or end that function.

TABLE 7-1 DST Category Result Segment Format

Components of Result Field	Type	Max Length
First Location Identifier		
Code 1	ST	80
Text for code 1	ST	200
Nature of code 1	ID	12
Code 2	ST	80
Text for code 2	ST	200
Nature of code 2	ID	12
Second Location Identifier		
(Similar to above)		
Distance Value	**NM**	**20**

TABLE 7-2 Examples of Distance Identifiers

Identifier	Meaning
T-10147^T-12171	External occipital protuberance (inion) to frontonasal suture (nasion) distance
T-Y0171-LFT^T-Y0171-RGT	Left preauricular area to right preauricular area distance
T-Y0120^T-10560	Vertex (central) region to fifth cervical vertebra distance
T-10560^T-10770	Fifth cervical vertebra to third lumbar vertebra distance
T-11310-SUP^T-Y8300	Superior clavicle[A] to elbow distance
T-11310-LFT-SUP^T-Y8300-LFT	Left superior clavicle[A] to left elbow distance
T-11310-LFT-SUP^T-11310-RGT-SUP	Left superior clavicle[A] to right superior clavicle[A] distance
T-11310-LFT-SUP^T-Y8600-LFT	Left superior clavicle[A] to left wrist distance
T-X9180-RGT-LC6^T-X9180-RGT-LC9	Right distal arm/thigh portion median nerve to right distal forearm/leg portion median nerve distance
T-Y9100-LFT-ANT^T-Y9100-LFT-PST	Left anterior thigh to left posterior thigh distance
T-13882-BEL^T-13882-INS	Belly abductor pollicis brevis muscle to insertion abductor pollicis brevis muscle distance

[A]*Superior clavicle* is used to refer to Erb's point.

TABLE 7-3 STM Category Result Segment Format

Components of Result Field	Type	Max Length
Stimulus Status	**ID**	**8**
Stimulus Type and Electrode Names		
Stimulus type	ID	8
Cathodal electrode name	ST	8
Anodal electrode name	ST	8
Stimulus Location Identifier		
Code 1	ST	80
Text for code 1	ST	200
Nature of code 1	ID	12
Code 2	ST	80
Text for code 2	ST	200
Nature of code 2	ID	12
Stimulus Rate		
Most common stimulus rate	NM	20
...		
Least common stimulus rate	NM	20
Stimulus Duration		
Most common stimulus duration	NM	20
...		
Least common stimulus duration	NM	20
Stimulus Intensity		
Most common stimulus intensity	NM	20
...		
Least common stimulus intensity	NM	20
Stimulus Intensity Units		
Units code 1	ST	80
Text for units code 1	ST	200
Nature of units code 1	ID	12
Units code 2	ST	80
Text for units code 2	ST	200
Nature of units code 2	ID	12
Stimulus Frequency or Color		
Most common stimulus freq. or color	NM/ST	20
...		
Least common stimulus freq. or color	NM/ST	20
Visual Stimulus Contrast		
Most common visual stim. contrast	NM	20
...		
Least common visual stim. contrast	NM	20
Visual Stimulus Pattern Type		
Most common visual stim. pattern type	ID	8
...		
Least common visual stim. pattern type	ID	8
Visual Stimulus Pattern Element Size or Spatial Period		
Most common pattern element size/ spatial period	NM	20
...		
Least common pattern element size/ spatial period	NM	20
Size of Visual Field Stimulated	**NM**	**20**

TABLE 7-4 Stimulus Type Codes for Somatosensory or NCS Stimuli

Code	Meaning
ECD	Electric stimulus at given location, cathode distal to anode
ECP	Electric stimulus at given location, cathode proximal to anode
ELC	Electric stimulus through specified electrode(s)
MAG	Magnetic stimulus at specified location
SST	Somatosensory tester stimulus (percussion hammer)

TABLE 7-5 Stimulus Type Codes for VEP/AEP Stimuli and Calibration Signals

Code	Meaning
Visual stimuli	
FLS	Diffuse light flash stimulus
LAD	Diffuse light appearance or disappearance stimulus
LSM	Sinusoidally modulated diffuse light stimulus
PRV[A]	Pattern reversal stimulus, full field
PRVLH[A]	Pattern reversal stimulus, left half field
PRVRH[A]	Pattern reversal stimulus, right half field
PRVTH[A]	Pattern reversal stimulus, top half field
PRVBH[A]	Pattern reversal stimulus, bottom half field
PRVLT[A]	Pattern reversal stimulus, left top quadrant
PRVLB[A]	Pattern reversal stimulus, left bottom quadrant
PRVRT[A]	Pattern reversal stimulus, right top quadrant
PRVRB[A]	Pattern reversal stimulus, right bottom quadrant
Auditory stimuli	
CLKRA	Click auditory stimulus, rarefaction polarity
CLKCO	Click auditory stimulus, condensation polarity
CLKAL	Click auditory stimulus, alternating polarity
FCLRA	Filtered click stimulus, rarefaction polarity
FCLCO	Filtered click stimulus, condensation polarity
FCLAL	Filtered click stimulus, alternating polarity
TONRA	Tone auditory stimulus, rarefaction polarity
TONCO	Tone auditory stimulus, condensation polarity
TONAL	Tone auditory stimulus, alternating polarity
GSWRA	Gated sine wave (tone pip), rarefaction polarity
GSWCO	Gated sine wave (tone pip), condensation polarity
GSWAL	Gated sine wave (tone pip), alternating polarity
LOGRA	Logon auditory stimulus, rarefaction polarity
LOGCO	Logon auditory stimulus, condensation polarity
LOGAL	Logon auditory stimulus, alternating polarity
MSK	Continuous masking noise
Calibration signals	
CAL	Square wave calibration pulse
SIN	Sine wave calibration signal

[A]May substitute **PFL** for **PRV** to indicate pattern flash stimulus, or **PAD** for **PRV** to indicate pattern appearance or disappearance stimulus, or **PSM** for **PRV** to indicate sinusoidally modulated pattern contrast stimulus.

TABLE 7-6 Examples of SNOMED Stimulus Location Codes

Code	Meaning
T-XX000-LFT	Left eye
T-XY000-RGT	Right ear
T-X9180-LFT-LC9	Left distal forearm/leg portion median nerve
T-X9450-BIL-LC9	Bilateral distal forearm/leg portion tibial nerve
T-X9174-LFT	Left ulnar nerve, palmar branch

TABLE 7-7 Visual Stimulus Color Codes

Code	Meaning	Code	Meaning
WHT	White	BLU	Blue
RED	Red	IND	Indigo
ORG	Orange	VIO	Violet
YEL	Yellow	MAG	Magenta
GRN	Green	CYA	Cyan

TABLE 7-8 Visual Pattern Stimulus Type Codes

Code	Meaning
CHK	Checkerboard pattern
HBG	Horizontally oriented bar grating
VBG	Vertically oriented bar grating
HSG	Horizontally oriented sine wave grating
VSG	Vertically oriented sine wave grating
WMG	Windmill grating
DBD	Dart board
CPX	Complex

TABLE 7-9 MED Category Result Segment Format

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

TABLE 7-10 DEV Category Result Segment Format

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

TABLE 7-11 CNP Category Result Segment Format

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

TABLE 7-12 ANA Category Result Segment Format

Components of Result Field	Type	Max length
Annotation or Analysis		
Single or first channel number	NM	4
Annotation source or algorithm name	ID	20
Annotation or analysis type	ID	20
Last channel number	NM	4
Montage number	NM	4
Annotation text	ST	200
Date/time of annotation or analyzed data	TS	26
Duration of annotation or analyzed data	NM	20
Date/time annotation or analysis performed	TS	26
Analysis Parameter 1		
Parameter value	ST	200
Parameter name	ST	8
Units code 1	ST	80
Text for units code 1	ST	200
Nature of units code 1	ID	12
Units code 2	ST	80
Text for units code 2	ST	200
Nature of units code 2	ID	12
Analysis Parameter 2, etc. ...		

TABLE 7-13 Standard Source or Algorithm Names

Code	Meaning
MAN	Manual annotation at time of data acquisition
MACH	Machine-generated annotation at time of data acquisition
TECH	Technician annotation or feature marking during review
PHYS	Physician annotation or feature marking during review
SPSZDT	Automated spike and seizure detection algorithm
AUTO	Automated (computer) feature detection algorithm
PEAK	Simple automated peak detection algorithm
EKG	Automated EKG feature identification algorithm
CAL	Automated calibration mark detection/analysis algorithm
FFT	Spectral analysis based on Fast Fourier Transform

TABLE 7-14 Annotation Type Codes and Text for Frequently Used Textual Annotations

Code	Abbreviated Text	Meaning
EOPN	Eyes open	Eyes opened by subject
ECLO	Eyes closed	Eyes closed by subject
EHOP	Eyes held open	Eyes held opened
EHCL	Eyes held closed	Eyes held closed
SUPN	Supine	Subject lying supine
PRON	Prone	Subject lying prone
LATR	Lat recumbent	Subject lying in lateral recumbent position
MOVE	Moves	Subject moves
MVLE	Leg movement	Subject's lower extremity moves
SWAL	Swallows	Subject swallows
SNOR	Snores	Subject snores
APNE	Apnea	Subject has apnea
TALK	Talks	Subject talks
TLKS	Talks in sleep	Subject talks in sleep
COUG	Coughs	Subject coughs
STAN	Stands	Subject stands up
WALK	Walks	Subject walks
NOIS	Noise	Noise in recording area
TAPS	Taps	Technician taps subject (to keep awake)
TAWA	Tech awakens	Technician awakens subject deliberately
CALL	Call	Call subject (to awaken or keep awake)
AWAK	Awake	Subject awake and alert
DROW	Drowsy	Subject drowsy
ASLP	Asleep	Subject asleep
COMA	Comatose	Subject comatose (unresponsive and unarousable)
BBIO	Begin biocal	Begin biocalibration section (all channels same input)
EBIO	End biocal	End biocalibration section
BGHV	Begin HV	Beginning of hyperventilation
ENHV	End HV	End of hyperventilation
BPHO	Begin photic	Beginning of photic stimulation
EPHO	End photic	End of photic stimulation
BMED	Begin med	Begin continuous administration of a medication (a MED category result segment could define further)
EMED	End med	End continuous administration of a medication
BSEZ	Begin seizure	Onset of a clinical seizure or *spell* (other annotations describe the nature of the recorded seizure)
ESEZ	End seizure	End of a clinical seizure or *spell*
B*xxx*[A]	Begin *xxx*	Beginning of a special procedure (the nature of which is specified by *xxx*, for example, reading, looking at pattern, etc.)
E*xxx*[A]	End *xxx*	End of a special recording procedure specified by *xxx*
TSPK	"text"	*Text* represents words spoken to subject by technician
SSPK	(text)	*Text* represents words spoken by subject

[A] *xxx* represents a unique code for the special recording procedure or condition.

TABLE 7-15 SEL Category Result Segment Format

Components of Result Field	Type	Max length
Montage Number	**NM**	**4**
Montage Function	**ID**	**8**

TABLE 7-16 Montage Function Identifiers

Code	Meaning
WDI	Waveform screen display
WPR	Waveform printing
WDE	Waveform feature detection (such as spike, seizure)
WAN	Waveform analysis (such as frequency spectra)
WST	Waveform data storage (on magnetic or optical media)

TABLE 7-17 Analysis Type Codes and Associated Parameter Names

NOTE—*Peak* usually refers to the most prominent or commonly identified peak.

Code	Parameter	Code Meaning / Parameter Meaning
EEG/Polysomnogram Features (TECH, PHYS, SPSZDT, AUTO Algorithms)		
NOTE—Where parameters and meanings are omitted, they are identical to those for UNF.		
UNF		Unidentified feature
	PKLA	Peak latency (time from start of epoch to peak) of feature
	ONLA	Onset latency (time from start of epoch to onset) of feature
	TODR	Total duration (time from onset to end) of feature
	PKDR	Peak duration or rise time (time from onset to peak) of feature
	PKAM	Peak-to-peak amplitude of feature
EPI		Epileptiform discharge
SHT		Sharp transient
WIC		Wicket
SSS		Small sharp spike
TRI		Triphasic wave
LAM		Lambda wave
SHW		Sharp wave
SPK		Spike
MSP		Multiple spikes
	As for UNF plus:	
	NREP	Number of repetitions of spikes
	FRQ	Repetition frequency of spikes
SPW		Spike and wave
	SPPKLA	Peak latency of the first spike
	SPONLA	Onset latency of the first spike
	SPTODR	Total duration of the spikes
	SPPKDR	Peak duration of the spikes
	SPPKAM	Peak-to-peak amplitude of spikes
	WAPKLA	Peak latency of the first wave
	WAONLA	Onset latency of the first wave
	WATODR	Total duration of the wave
	WAPKDR	Peak duration of the wave
	WAPKAM	Peak-to-peak amplitude of waves
	NREP	Number of repetitions of pattern
	FRQ	Repetition frequency of pattern
MSW		Multiple spike and wave
	As for SPW	
SEZ		Seizure
	ONLA	Onset latency of the electrographic seizure
	TODR	Total duration (time from onset to end of seizure)
	RHYTHM	Rhythmicity of seizure
	FRQ	Average frequency of seizure
	AMP	Average amplitude of seizure
VWV		V wave
FWV		F wave
SPN		Spindle
	ONLA	Onset latency of the spindle
	TODR	Total duration of the spindle
	FRQ	Average frequency of spindle
	PKAM	Peak-to-peak spindle amplitude
KCP		K complex
PST		POST
SAW		Sawtooth wave
FUS		Slow fused transient
EYE		Eye movement artifact
REM		Rapid eye movement
ELC		Electrode artifact
MUS		Myogenic (EMG) artifact
SWL		Swallowing artifact
GLS		Glossokinetic artifact
MOV		Movement artifact
EKG		Electrocardiographic artifact
PUL		Pulse artifact
SWT		Sweat artifact
RSP		Respiratory artifact
SLS		Begin new sleep stage
	ONLA	Onset latency
	SLPSTG	Sleep stage (see Table B -50)
ARO		Arousal from sleep
	ONLA	Onset latency
AWA		Awakening from sleep
	ONLA	Onset latency
Nerve Conduction Peaks (TECH, PHYS, PEAK Algorithms)		
NOTE—Where parameters and meanings are omitted, they are identical to those for CMAP.		
CMAP		Compound muscle action potential
	ONLA	Onset latency
	PKLA	Peak latency
	TODR	Total duration
	PKDR	Peak duration (rise time)
	PKAM	Peak-to-peak amplitude
	PBAM	Peak-to-baseline amplitude
	PKAREA	Area under peak
SNAP		Sensory nerve action potential
FWAV		F-wave
AWAV		Axon reflex (A-wave)
SIRD		Stimulus-induced repetitive discharge
HREF		H-reflex
CREF		C-reflex (long loop reflex)
SLPD		Silent period
	ONLA	Onset latency
	TODR	Total duration
R1		Blink reflex response 1
	ONLA	Onset latency
	PKAM	Peak-to-peak amplitude
R2		Blink reflex response 2
	As for blink response 1	

TABLE 7-17 Continued

EMG Potentials (TECH, PHYS, AUTO Algorithms)

NOTE—Where parameters and meanings are omitted, they are identical to those for MUP.

MUP	Motor unit potential	FIB	Fibrillation potential
TODR	Total duration	POS	Positive sharp wave
PKDR	Peak duration (rise time)	FAS	Fasciculation potential
PKAM	Peak-to-peak amplitude	MYT	Myotonic discharge
PBAM	Baseline-to-peak amplitude	AFT	After-discharge
PKAREA	Area under peak	CRD	Complex repetitive discharge
FRQ	Repetition (firing) frequency	MYK	Myokymic discharge
NPHASE	Number of phases	NMT	Neuromyotonic discharge
NTURN	Number of turns	CRA	Cramp discharge
INS	Insertion activity	DOU	Doublet
SFD	Single fiber discharge	TRP	Triplet
EPN	End plate noise	MLT	Multiplet
EPS	End plate spike	ITR	Iterative discharge

VEP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

N1	P100 (or P2)	N145 (or N3)
P50 (or P1)	N100	P175 (or P3)
N75 (or N2)	N105	P300
P75	P135	

Brainstem AEP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

I	Wave I	IV	Wave IV	Vc	Wave V - contralateral
II	Wave II	IVc	Wave IV - contralateral	VI	Wave VI
III	Wave III	V	Wave V		

Middle Latency AEP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

N0	Na	Nb
P0	Pa	Pb

Long Latency AEP/ERP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

Nb	N1	N2
P1 (or Pb)	P2	P300 (or P3)

Median/Ulnar Nerve SEP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

EL (or N5)	Elbow	N14	
N9	Erb's point	N20	Scalp potential
P9		P27	Scalp potential
N11	Cervical	P30	Scalp potential
P11		N30	Scalp potential
N13	Cervical dorsal root entry zone, N/P13	N140	Long-latency scalp potential
P13		P190	Long-latency scalp potential
P14	Cervical ?	P300	Long-latency scalp potential

Peroneal Nerve SEP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

LU	Lumbar potential	CV	Cervical potential
THL	Low thoracic potential	P27	Scalp potential
THH	High thoracic potential	N35	Scalp potential

Tibial Nerve SEP Features (TECH, PHYS, PEAK Algorithms)

NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.

PF (or N8)	Popliteal fossa potential	N33	Scalp potential
LU (or N22)	Lumbar potential	P37	Scalp potential
TH	Thoracic potential	N45	Scalp potential
CV (or N30)	Cervical potential	P58	Scalp potential

TABLE 7-17 *Continued*

Code	Meaning Parameter	Code Meaning	Meaning ParameterMeaning
	Generic Nerve SEP Features (TECH, PHYS, PEAK Algorithms)		
	NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.		
I		IV	
II		V	
III		VI	
	Electroretinogram Features (TECH, PHYS, PEAK Algorithms)		
	NOTE —all *Code*s have associated *Parameter*s of PKLA and PKAM.		
ERP	Early receptor potential	BP	Photopic B wave
A	A wave	BS	Scotopic B wave
AP	Photopic A wave	AFP	Afterpotential
AS	Scotopic A wave	C	C wave
B	B wave		
	Electrocochleogram Features (TECH, PHYS, PEAK Algorithms)		
CM	Cochlear microphonics	NAP	Nerve action potential
ONLA		PKLA	
PKAM		PKAM	
SP	Summating potential		
ONLA			
PKAM			
	Movement-Related Potential Features (TECH, PHYS, PEAK Algorithms)		
BP	Bereitschaftspotential	P1 (or PMP)	Premotion positivity
ONLA		PKLA	
PKAM		PKAM	
NS	Negative slope	N2	2nd negative peak
ONLA		PKLA	
PKAM		PKAM	
N1	1st negative peak	P2 (or RAP)	Reafferente Potentiale
PKLA		PKLA	
PKAM		PKAM	
	Special-Purpose Channel Features (TECH, PHYS, AUTO Algorithms)		
EMG	EMG potential	TODR	Total duration (between systolic pressure peaks)
ONLA, TODR, PKAM		PKDR	Peak duration (from end diastole to systolic peak)
ACC	Accelerometer signal	PKAM	Peak amplitude (systolic-diastolic pressure difference)
ONLA, TODR, PKAM		RAF	Respiratory air flow monitor
RST	Response tester (Tech response)	TODR	Total duration of flow
ONLA, TODR		PKAM	Peak amplitude of flow
RSS	Response tester (Subject resp.)	ONDR	Duration of preceding apnea
ONLA, TODR		RATE	Average respiratory rate
SST	Somatosensory stimulus	RES	Respiratory effort monitor
ONLA, TODR		As for RAF, *effort* replaces *flow*	
FLS	Flash (strobe) stimulus	OXY	Oxygen saturation monitor
ONLA, TODR		TODR	Total duration of oxygen desaturation
VIS	Other visual stimulus	PKAM	Peak amplitude of oxygen desaturation (baseline saturation minus lowest recorded saturation for preceding apnea)
ONLA, TODR			
AUD	Auditory stimulus	EPH	Esophageal pH monitor
ONLA, TODR		TODR	
ELS	Electric stimulus	PKAM (of acidity)	
ONLA, TODR		NPT	Nocturnal penile tumescence
SYS	Systolic blood pressure peak	TODR	
PKLA	Peak latency (to systolic pressure peak)	PKAM (of tumescence)	

TABLE 7-17 *Continued*

EKG Features and Intervals (TECH, PHYS, EKG Algorithms)

Code	Parameter	Meaning	Code	Parameter	Meaning
P		P wave	QT		QT interval
	PKAM, TODR			INTV	Time from QRS to T
Q		Q wave	PR		PR interval
	PKAM, TODR			INTV	Time from P to QRS
R		R wave	ST		ST segment elevation
	PKAM, TODR			ELEV	Elevation of ST segment
S		S wave	RR		Ventricular interval
	PKAM, TODR			INTV	Interval from QRS to QRS
T		T wave		RATE	Reciprocal of interval
	PKAM, TODR		PP		Atrial interval
U		U wave		As for RR; interval from P to P	
	PKAM, TODR				
QRS		QRS interval			
	INTV	Total complex duration			

Calibration Pulse Analysis (TECH, PHYS, CAL Algorithms)[A]

Code	Parameter	Meaning	Code	Parameter	Meaning
ON		Calibration on pulse	OFF		Calibration off pulse
	PKAM	Peak amplitude of pulse		PKAM	Peak amplitude of pulse
	BASE	Baseline value (between calibration pulses)		BASE	Baseline value (between calibration pulses)
	LFF	Inferred low frequency filter setting in effect		LFF	Inferred low frequency filter setting in effect

Frequency Spectral Analysis (FFT Algorithm)

Code	Parameter	Meaning	Code	Parameter	Meaning
SPEC[B]		Multi-bin spectrum		NRANGE	Number of frequency ranges
	LOFRQ	Lowest frequency in spectrum		RANGE1	Name of first frequency range (for example, *alpha*)
	HIFRQ	Highest frequency in spectrum		LOFRQ1	Low frequency of range one
	NBINS	Number of bins in spectrum; the size of each bin is (HIFRQ-LOFRQ)/NBINS		HIFRQ1	High frequency of range one
				AMP1	Total amplitude (square root of power) in range one
	AMP1	Amplitude (square root of power) in bin one		POW1	Total power in range one
	POW1	Power in bin one		PKFRQ1	Peak frequency in range one (frequency within range having highest amplitude in maximum resolution spectrum)
	PHA1	Phase angle (-180 to 180°) in bin one			
	AMP2	Amplitude in bin two		MNFRQ1	Mean frequency in range one (found by summing products of powers and frequencies in each bin of maximum resolution spectrum, and dividing by sum of powers)
	POW2	Power in bin two			
	PHA2	Phase angle in bin two			
	. . .			RANGE2, etc. ...	
RANG[C]		Spectrum by frequency ranges			

[A]This analysis algorithm detects each calibration pulse on and off transition and fits the recorded waveform in each channel by least-squares regression to an exponential curve, thereby determining the peak amplitudes, baselines, and time constants. The peak amplitudes can be used to calculate sensitivity correction factors, the baseline values can be used to correct for dc offsets, and the time constants can be used to calculate low-frequency filter settings which can be compared with the nominal settings for each channel.

[B]This analysis type generates a multi-bin frequency spectrum, with each of the contiguous equal size bins having an associated amplitude or power, and optional phase angle.

[C]This analysis type generates amplitude or power, peak frequency, and mean frequency data for a small number of named frequency ranges, not necessarily of equal size, possibly overlapping, and not necessarily contiguous.

TABLE 7-18 Example Segment Sequence Required to Define and Select Auxiliary Montages

Segment	Function
ELC-0	Define all electrodes common to all montages
MTG-1	Start definition of montage 1
ELC-1	Optional—define all electrodes unique to montage 1
CHN-1	Define channels in montage 1 (e.g. using common Cz reference)
MTG-2	Start definition of montage 2
ELC-2	Optional—define all electrodes unique to montage 2
CHN-2	Define channels in montage 2 (e.g. longitudinal bipolar)
MTG-3, etc. ...	
MTG-1	Select montage 1 for data transmission
TIM-1	Set starting time and sampling interval of epoch 1
SEL-2(WDI)	Select montage 2 for function **WDI** (waveform display)
WAV	Define waveform data for epoch 1 (using montage 1)
⋮	(data will be displayed after reformatting to montage 2)
SEL-3(WDI)	Select montage 3 for function **WDI** (waveform display)
WAV	Define more epoch 1 waveform data (using montage 1)
⋮	(data will be displayed after reformatting to montage 3)
SEL-2(WPR)	Select montage 2 for function **WPR** (waveform printing)
WAV	Define more epoch 1 waveform data (using montage 1)
⋮	(data will be displayed after reformatting to montage 3 and will be printed after reformatting to montage 2)
SEL-Null(WDI)	Deselect montage for function **WDI** (waveform display)
WAV	Define more epoch 1 waveform data (using montage 1)
⋮	(data will be printed after reformatting to montage 2, but will no longer be displayed)
MTG-4	Select montage 4 for data transmission
WAV	Define more epoch 1 waveform data (using montage 4)
⋮	(data will be printed in montage 4 without reformatting)
SEL-Null(WPR) +2(WDI)	Deselect montage for function **WPR** (waveform printing), and select montage 2 for function **WDI** (waveform display)
WAV	Define more epoch 1 waveform data (using montage 4)
⋮	(data will be displayed after reformatting to montage 2, but will no longer be printed)

8. Result Segments Used to Transmit Reports and Interpretation

8.1 The following categories of result segments are used to transmit the electrophysiologic study results and interpretation. This may include quantitative and qualitative results, diagnostic impressions and the anatomic sites to which they apply, a technical summary or report on the study, an interpretation for the ordering physician's use, an addendum to the report and interpretation, and recommendations for follow-up tests. These result segment categories do not contain information needed by an expert to interpret the waveforms, but can be used for storage and transmission of complete reports for the medical record. These categories are not used in Level I implementations but are used in Levels II and greater.

Null Category

8.2 In keeping with the usage recommended by NCCLS LIS 5-A for reporting quantitative and qualitative results from other laboratories (for example, clinical chemistry and hematology, echocardiography, electrocardiography, spirometry, etc.), a result segment which does not contain any information category code is used to transmit a single numeric or coded entry test result with diagnostic significance, such as a velocity, latency, amplitude, frequency, etc. The result is placed in the observation value field of the result segment (with a value type of NM = numeric or CE = coded entry); for numeric data the units of the value (such as m/s = metre per second, ms = millisecond, uv = microvolt, hz = hertz, or % = percent), the normal range defined by the laboratory, and abnormal/change flags may be transmitted in other fields of the result segment.

8.2.1 Result segments of this type are generally transmitted after the waveform and technical data for the study (if any) but before a descriptive report and interpretation. The data contained in these segments may be displayed by the receiving system in tabular form, or used to construct graphs or plots (such as somnograms plotting sleep stage against epoch number, or latency-intensity curves plotting EP peak latency against stimulus intensity), or they may be stored in a local result database (temporarily or permanently) if desired. Segments of this type are most commonly used when transmitting EP, ERP, or NCS results (peak amplitudes, latencies, morphologies, conduction velocities, and differences of these quantities), often instead of a narrative report. They are often used also for transmitting EMG study results (such as abundance or frequency of insertional activity, fibrillations and fasciculations, recruitment, motor unit amplitude, motor unit duration, number of phases or turns in a motor unit, and motor unit variability) organized by muscle tested. They may be used also by some laboratories to transmit results of EEG, PSG, and MSLT studies in tabular form (waveforms or sleep events or stages detected and their abundance, amplitude, frequency, duration, asymmetry, reactivity, latency, distribution, and other characteristics), organized by section of recording (awake, sleep, photic stimulation, etc.).

8.2.2 In these result segments, velocity, latency, amplitude, duration, and other quantitative values may be reported using either numeric or coded entry value type, while peak or waveform morphologies and other descriptive items are always coded entries. The coded entry format is used for quantitative results when grading those results on an absolute (low, moderate, or high) or relative scale (decreased, normal, or increased) for diagnostic or classification purposes. A single quantitative result may thus be transmitted either as a number (value type = NM) or as a grade (value type = CE), or two consecutive result segments with the same test/observation ID and observation subID, the first using value type NM and the second CE, may be used. In the latter case, fields 7 to 13 (units, normal range, etc.) of the second segment are not present. For example, a conduction velocity could be sent both as a numeric result (20 m/s) and a graded result (Code 1 = markedly decreased). The code in the test/observation ID field identifies the particular study performed, the relevant portion of the study and the particular peak, waveform, or activity or the particular muscle or nerve and observation to which the value applies, and the type of value (velocity, latency, amplitude, etc.) according to the scheme for test/observation identifiers described in Appendix B . If multiple results with the same test/observation ID are transmitted (for example, motor NCS velocities derived from one proximal site but different distal sites, or sleep event frequencies given with two different units like number per hour and total for the recording), a unique observation subID must be used for each result.

8.2.3 In some situations in which coded entries are used (for example, when transmitting the distribution or anatomic localization of EEG waveforms), a single result segment may contain more than one coded entry, each defining a part of the result (similar to the ANT category result segment). This is allowed only when a single result cannot be described by one coded entry, not when it is necessary to transmit entirely separate results. When value type CE is used, the observation value field of the result segment contains one or more coded entries in the six-component format defined by the NCCLS LIS 5-A and HL7 standards, separated by repeat (~) delimiters. Each coded entry defines one part of the result. The format of the null category result segment using CE value type is summarized in Table 8-1.

8.2.4 The first and fourth components of each coded entry would contain alphanumeric test result codes. The second and fifth components could contain text describing or further qualifying the alphanumeric result codes. The third and sixth components would contain an identification of the coding system used in the first and fourth components (for example, **SNM+&TOPO** for SNOMED topographic localization codes with qualifiers; **AS4&xxxx** for **AS4** universal codes for test results, where *xxxx* is one of the specific code table identifiers for test results listed in Appendix B ; or **99zzz** or **L** for locally defined codes, where each *z* represents an alphanumeric character). There is no single default defined for the third component, since the coding system used depends on the particular test result, as identified by the test/observation ID field; the usual coding systems used for the various **AS4** universal test/observation IDs for electroneurophysiologic studies are given in Appendix B . The default for the sixth component is **L**, local codes.

ANT Category

8.3 This category of result segment may be used to transmit the coded anatomic site (localization) which applies to a subsequently transmitted diagnostic impression (IMP) category result segment. That is, if a diagnostic impression has an associated site or localization, that site or localization must be specified in an ANT category result segment transmitted just prior to the IMP category result segment.

8.3.1 The observation value field of this category of result segment contains one or more coded entries in the six-component format defined by NCCLS LIS 5-A, separated by repeat (~) delimiters. Each coded entry defines one anatomic site; when more than one is used, the actual anatomic localization is taken to be more diffuse, encompassing all of the specified sites. The format of each coded entry in an ANT category result segment is given in Table 8-2.

8.3.2 The first and fourth components of each coded entry contain alphanumeric codes defining the site or localization. The second and fifth components could contain text defining the localization. The third and sixth components could contain an identification of the coding system used for the first and fourth components. A typical value for the third component is **SNM+&TOPO**, SNOMED topographic location codes with qualifiers, as in Appendix A ; an alternative is **AS4&DIST**, **AS4** universal codes for specifying anatomic distribution, as in Appendix B . The default for the sixth component is **L**, local codes.

8.3.3 Table 8-4 shows some examples of anatomic localizations for various classes of studies using SNOMED or **AS4** codes.

IMP Category

8.4 This category of result segment is used to transmit a coded diagnostic impression for the entire study or for a portion of the study. Multiple IMP category result segments can be used if there are multiple parts to the study which each have an associated diagnosis (for example, one for the awake EEG, another for the sleep recording, another for hyperventilation, etc.). Multiple IMP category result segments can also be used if there are separate diagnoses corresponding to separate anatomic sites or localizations (for example, left frontal, right temporal, etc.); in this case, the site or localization must be specified by an immediately preceding ANT category result segment. Multiple IMP category result segments are also used to transmit multiple independent diagnoses with the same anatomic localization for the same portion of the recording (for example, *technically difficult* and *continuous low-amplitude theta activity*). A single IMP category result segment can include more than one diagnosis, but only when such diagnoses are modifiers of or represent different aspects of the same diagnostic impression, not to report an entirely separate finding (for example, *slightly increased duration motor unit potentials* and *occasional fibrillation potentials*). An IMP category result segment can also express the probability of the diagnosis (in field 10), if desired. The observation value field of this category of result segment contains one or more coded entries in the six-component format defined by NCCLS LIS 5-A, separated by repeat (~) delimiters. Each coded entry defines one of the related diagnoses. The format of each coded entry in an IMP category result segment is given in Table 8-3.

8.4.1 The first and fourth components of each coded entry would contain alphanumeric diagnostic codes. The second and fifth components could contain text defining the diagnosis. The third and sixth components could contain an identification of the coding system used for the first and fourth components. A typical value for the third component is **I9C** (ICD-9-CM diagnostic codes; International Classification of Diseases, Clinical Modification); alternatives include **SNM&DIAG** (SNOMED diagnostic codes), **ICSD** (ICSD diagnostic codes**(11), (12)**), or **AS4&xxxx** (**AS4** universal diagnostic codes), where *xxxx* is one of the specific diagnosis code table identifiers for a particular class of electroneurophysiologic studies listed in Appendix B . The default for the sixth component is **L**, local codes.

8.4.2 Table 8-5 shows some examples of diagnostic impressions for various classes of studies using ICD-9-CM or **AS4** codes; note that ICD-9-CM expresses clinical diagnostic interpretations, while **AS4** codes describe the findings of the study only.

GDT Category

8.5 This category of result segment is used to transmit the interpreter's report for the electrophysiologic study. The report generally describes the recorded waveforms and other results of the study in a fashion that would convey a reasonably precise general impression of the study to another expert, but does not provide an interpretation. Such a narrative report is almost always supplied for EEG and PSG studies, is usually supplied for EMG studies, and is sometimes supplied for NCS, EP, and ERP studies (in addition to the numeric and coded entry results transmitted in null category result segments, which can be displayed in tabular form by the receiving system). This category result segment is generally transmitted after the waveform and technical data for the study. The text of the report is contained in the observation value field of the GDT category result segment. Any length of text (up to 64K characters) may be included. Repeat delimiters (~) are used as line terminators. If multiple paragraphs are included in the report, they should be separated from each other by two repeat delimiters (~~).

MDT Category

8.6 This category of result segment is used to transmit the interpretation of the electrophysiologic study. The interpretation generally specifies the possible or likely implications of the study, differential diagnosis, and other conclusions in a fashion that would be meaningful to the ordering physician who is not necessarily an expert in electrophysiology. Such an interpretation is usually supplied for all electrophysiologic studies, although it may not be present for normal studies (for which a diagnosis of *normal* is transmitted in an IMP category result segment) or other studies for which the diagnostic impression needs no further interpretation. This category result segment is generally transmitted after the waveform and technical data for the study. The text of the interpretation is contained in the observation value field of the MDT category result segment. Any length of text (up to 64K characters) may be included. Repeat delimiters (~) are used as line terminators. If multiple paragraphs are included in the report, they should be separated from each other by two repeat delimiters (~~).

ADT Category

8.7 This category of result segment is used to transmit the interpreter's addenda to the report and interpretation, if needed. An addendum may be used to report additional information not specified in the report or interpretation but relevant to the ordering physician. This category result segment is generally transmitted after the waveform and technical data and the report and interpretation. The text of the report addendum is contained in the observation value field of the ADT category result segment. Any length of text (up to 64K characters) may be included. Repeat delimiters (~) are used as line terminators. If multiple paragraphs are included in the report, they should be separated from each other by two repeat delimiters (~~).

REC Category

8.8 This category of result segment specifies a recommendation for a follow-up test in the future. The observation value field of this category of result segment contains a single coded entry in the six-component format defined by the NCCLS LIS 5-A. The format of the REC category result segment is summarized in Table 8-6.

8.8.1 The first and fourth components would contain an alphanumeric code for the recommended test or study, the second and fifth components could contain the corresponding text descriptions, and, if desired, the time in days after which the follow-up test should be performed, and the third and sixth components could contain an identification of the coding system used for the first and fourth components. A typical value for the third component is **AS4&TEST**, the **AS4** universal test/

observation ID codes given in Appendix B . The default for the sixth component is **L**, local codes. If more than one follow-up study is recommended, each such recommendation is transmitted in a separate REC category result segment.

TABLE 8-1 Null Category Result Segment—Format for Coded Entries

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

TABLE 8-2 ANT Category Result Segment Format

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

TABLE 8-3 IMP Category Result Segment Format

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

TABLE 8-4 Examples of Anatomic Localizations

Code	Description
EEG studies (using AS4&DIST codes)	
0016	Generalized, maximal right hemisphere
1300	Left anterior temporal and midtemporal
3210	Bilateral central and midtemporal
7007	Left hemisphere, maximal frontopolar and frontal and lateral frontal
9200	Independent left and right midtemporal
EEG studies (using qualified SNOMED codes, SNM+&TOPO)	
T-X2060-RGT	Right hemisphere
T-Y0150-LFT-ANT	Left anterior temporal region
T-Y0150-BIL	Bilateral temporal region
T-X2570	Hippocampus
EMG studies (using qualified SNOMED codes, SNM+&TOPO)	
T-13000-MLT-PRX	Multiple proximal skeletal muscle
T-14900-MLT	Multiple muscle of foot
T-14700-MLT-DST	Multiple distal muscle of leg
T-X7690-LFT-N5	Left number 5 cervical spine, nerve root
Motor/sensory NCS (using qualified SNOMED codes, SNM+&TOPO)	
T-X9001-MLT-DST	Multiple distal nerve
T-X9180-RGT-LC9	Right distal forearm/leg portion median n.
T-X9090-LFT	Left brachial plexus
EP studies (using AS4&DIST codes)	
0001	On left
0003	Bilaterally
EP studies (using qualified SNOMED codes, SNM+&TOPO)	
T-X2050	Brainstem
T-X8040-LFT	Left optic nerve

TABLE 8-5 Examples of Diagnostic Impressions

Code	Description
EEG studies (using AS4&EEGD codes)	
2	Technically difficult
4146	Rare atypical spike and wave complexes
6133	Frequent small sharp spikes
910218	Continuous low amplitude arrhythmic delta activity
EEG studies (using ICD-9-CM codes, I9C)	
345.6	Infantile spasms
046.1	Jakob-Creutzfeldt disease
EMG studies (using AS4&EMGD codes)	
5121	Occasional fibrillation potentials
7110	Increased abundance insertional activity
547926	Moderate frequency burst firing myokymic discharges
EMG studies (using ICD-9-CM codes, I9C)	
359.2	Myotonic disorders
710.4	Polymyositis
Motor NCS (using AS4&MNCD codes)	
119	Markedly decreased CMAP conduction velocity
613	Mildly increased CMAP latency
723	Increased F-wave latency
Motor NCS (using ICD-9-CM codes, I9C)	
354.0	Carpal tunnel syndrome
354.2	Lesion of ulnar nerve: cubital tunnel, tardy ulnar palsy
Transient VEP studies (using AS4&VEPD codes)	
634	Mildly increased P100 peak ipsilateral to contralateral latency difference
731	Increased P100 peak latency

TABLE 8-6 REC Category Result Segment Format

Components of Result Field	Type	Max length
Code 1	ST	80
Text for Code 1	ST	200
Nature of Code 1		
Coding system 1 mnemonic identifier	ID	5
Specific code table 1 identifier	ID	7
Code 2	ST	80
Text for Code 2	ST	200
Nature of Code 2		
Coding system 2 mnemonic identifier	ID	5
Specific code table 2 identifier	ID	7

9. Two-Way Communication Between Systems

9.1 *Communication Capabilities*—The NCCLS LIS 5-A standard defines some capabilities for two-way communication between independent computer systems. Its emphasis is primarily on communication between an order entry/result reporting system in a clinic or hospital (*requestor* or *placer* of an order) and a laboratory computer system (*producer* or *filler* of the order). It defines basic functions, such as electronic order transmission from the requestor to the producer and electronic result transmission from the producer to the requestor in response. NCCLS LIS 5-A also provides a request result (query) function by which the requestor can ask the producer for the status of previously ordered tests or for the results of these tests. The HL7 standard has capabilities for more general query-and-response transactions and also specifies details about message acknowledgment and error reporting. This Technical Standard extends two-way communication capabilities to include functions required for communication of control, waveform, and report data between cooperating machines within a laboratory and adds a simple error reporting facility to the NCCLS LIS 5-A message format. The NCCLS LIS 5-A message format is the recommended standard format for all two-way communication between machines within a given laboratory.

9.2 *Communication Channels*—Communication between cooperating machines within a laboratory, or between laboratory systems and external computer systems, is assumed to occur over *communication channels*. For example, communication channels, which are assumed to allow bidirectional information transfer, may be dedicated low- to medium-speed serial line interfaces using an appropriate software data transfer protocol, or they may be functional connections that have been established between machines through a high-speed network interface using appropriate software.

9.2.1 Communication between two machines requires at least one bidirectional communication channel, and many communications using this Technical Standard take the form of complete messages sent over this communication channel. For example, for machine **A** to communicate with machine **B**, **A** will construct a NCCLS LIS 5-A formatted message beginning with an H segment and ending with an L segment and send it to machine **B** by means of an **A-B** communication channel. Machine **B** will decode and process the message, and respond (if necessary) by sending an appropriate message (beginning with an H segment and ending with an L segment) back to machine **A** by means of the same **A-B** communication channel. In some cases, communication may continue with machine **A** sending another message to **B** in response, and so forth. In this scenario, the original message sent by machine **A** is an unsolicited message, while the other messages are response messages. The response messages in many cases would be sent within a brief time after receipt of the message to which they are a response (for example, seconds or minutes). In many (but not all) implementations, responses that take longer than this are instead treated as new, unsolicited messages that may initiate another back-and-forth communication. For example, a message ordering an EP study in three days may eventually (three days later) lead to a response in which the results of the study are returned to the original requestor, but the message containing results would be considered an unsolicited message at that time. Individual implementations can decide which messages elicit immediate responses and which do not, but guidelines are presented in this Technical Standard according to message type.

9.2.2 Some machines need to transmit long segments of data (particularly waveform data and related annotations) in a *real time* mode; that is, the data are transmitted as acquired or processed. Examples include an acquisition machine that transmits its waveform data in real time to a data storage and archival machine or to a real time display machine, or a seizure detection machine that receives continuous data in real time from an acquisition machine and transmits segments of data representing candidate seizure epochs as these are detected to a data storage machine. These transmissions may be performed over a separate communication channel from the primary communication channel used for briefer messages; such a communication channel may represent a physically distinct pathway (such as a serial line) or a separate logical pathway on the same network (such as Ethernet). Data transmission of this type takes the form of extended messages that begin with a header (H) segment sent at the time of opening the communication channel, followed by appropriate patient (P) and order (OBR) segments, followed by WAV category and ANA category result (OBX) segments, which are sent as they become available. Eventually (for example, on study completion), this transmission is ended by sending a message trailer (L) segment and closing the communication channel. Exchange of control and status information between the machines communicating data in this fashion can go on simultaneously with the transmission of data by using the primary communication channel between the two machines to send brief but complete messages.

9.3 *Electronic Ordering of Tests*—This Technical Standard, in keeping with NCCLS LIS 5-A and HL7, provides a means by which an electronic order entry system (which may be part of a hospital information system or a clinical practice computer system) may transmit an order for an electroneurophysiologic study to a laboratory computer system or device (for example, a digital EEG or EMG machine). Results (which may include waveform data and annotations, reports, or both) may be returned to the ordering system on completion of the study. When a clinical neurophysiology laboratory contains multiple devices or computer systems which communicate with each other to collectively process an order, this Technical Standard also provides a means by which order and result information can be shared among these communicating devices.

9.3.1 A specific example may illustrate several aspects of the electronic order process. A laboratory contains several waveform acquisition units (digital EEG, EMG/NCS, and EP machines), which transmit data to a central laboratory data storage, archive, and scheduling system; in addition, several waveform review systems (with displays, printers, or both) can receive data from the central laboratory system and display or print it. Interpretive reports concerning the studies may be entered by physicians reviewing the waveform data on the review systems, and these are transmitted back to the central laboratory system for local laboratory storage. An external clinical order entry system may send electronic orders to the central laboratory system, which may in turn send final interpretive reports to a hospital or clinic-wide laboratory information system for storage and archival, or for electronic display at terminals in clinic and hospital areas.

9.3.2 In this system, orders received by the central laboratory system need to be labeled with unique producer (diagnostic service) accession numbers for identification purposes. The orders (including associated patient and test identification and demographic data) then must be distributed as needed to the individual data acquisition units. This could be accomplished in several ways. In one scenario, when an order arrives at the central laboratory system, it could be sent immediately as an unsolicited transmission to one of the data acquisition units that was selected to process that order; it would then save the order and wait for a technician to connect the requested subject and begin the study. In a second possible scheme, the orders could be retained on file by the central laboratory system, and when a data acquisition unit finished the last study it would send a request for new orders to the central laboratory system, which would select an order from its pending file and transmit it to the data acquisition unit; it would wait for a technician to connect the requested subject and begin the study. In a third possible scenario, the orders could be retained by the central laboratory system, and when a new subject had been connected to a data acquisition unit and the technician specified the type of study to be performed (for example, EMG or EP), the acquisition unit would send a request for new orders specifying a particular patient and test identifier to the central laboratory system, which would select the matching order from its pending file and transmit it to the data acquisition unit.

9.3.3 Studies for which no previous orders had been received (for example, emergency cases or subjects who came without an appointment) could also be accommodated in these schemes if necessary. In the first and second schemes, a laboratory-generated order would be created at the request of laboratory desk personnel by means of a terminal interface to the central laboratory system, and it would be treated like an external order. In the third scheme, when the central laboratory system received a request for an order from the data acquisition unit and no corresponding pending order existed in the file, it would send an error indication to the data acquisition unit, which could then send back a message asking for a new generated order to be created; this order would be returned to the acquisition unit with the specified patient and test identifiers and a unique producer (diagnostic service) accession number.

9.3.4 The format of an NCCLS Standard LIS5-A message used to order an electroneurophysiologic test is as follows:

```
H    Message header segment
P    Patient identification segment
OBR  Order segment
OBX  Result segment (optional)
...
L    Message terminator segment
```

9.3.5 The OBR segment specifies a requestor (practice) accession number, which uniquely identifies this order from the standpoint of the original ordering system. If the order is generated internally by a laboratory and does not derive from an external source, this number may be the same as the producer accession number.

9.3.6 The producer (diagnostic service) accession number is generated internally by the laboratory and uniquely identifies the test among all tests performed by that laboratory. Although this number is omitted in the original message containing the order from an external source, it is included in all copies of the OBR segment transmitted to cooperating machines working on that order within the laboratory and also in the copy of the OBR segment returned with the results of the study (as a result header). Because the producer accession number must be unique for all studies performed by the laboratory, it is advantageous to assign the function of generating these numbers to just one of the machines in the laboratory (in the example given in 9.3.1 through 9.3.3, this could be the central laboratory system).

9.3.7 The OBR segment also specifies the type of study to be performed, the ordering physician, and many other details about the order. The requestor special field 1 and requestor special field 2 may be used as desired by the transmitter of an order to identify the order or transmit special instructions; they are returned unchanged to the transmitter when the order is acknowledged. An action code (required) indicates the type of order and the action to be taken regarding the order. The codes which are of most use in clinical neurophysiology laboratories are given in Table 9-1. Not all of these codes need be implemented by a given system. Code **A** may be used to add additional studies of a similar type to a previously transmitted order (for example, to add a BAEP study to a previously ordered VEP study); if the additional study cannot be accommodated as an extension to the previously scheduled study, code **A** may be treated as **N**, and a new study scheduled. Code **G** is not available to external ordering systems but is reserved for internal laboratory use in one of the following circumstances: *(1)* when an order for a generic test (*parent* order) leads to the generation internally of multiple *child* orders, all but the first of these *child* orders has action code **G** (see 4.7.2); *(2)* when the quantity-timing field of the OBR segment specifies that the test will be repeated at certain intervals for a specified duration, separate orders may be generated internally for each repetition of the test, using action code **G** in all but the first order; *(3)* when a test extends for a prolonged period of time (for example, prolonged EEG monitoring) and the laboratory handles this as multiple successive orders following in immediate succession (with the end time of each being the start time of the next), action code **G** is used in all but the first order (for example, a laboratory could generate a new order for each 24-h period of monitoring, or each time a data file on disk reaches maximum capacity and a new volume must be mounted or selected); *(4)* when a test is performed in a laboratory without any external order being received (as for an emergency study, or for a subject who comes without an appointment, or simply because no external electronic order entry system is implemented). Code **R** may be used when it is desired to change some data pertaining to a scheduled but not yet performed order (such as a change in clinical indication or order priority), or to change or send new data (such as equipment settings) regarding a test in progress. Code **S** is usually treated as identical to code **N**, since electroneurophysiologic tests are generally scheduled in advance and not performed immediately upon ordering.

9.3.8 An OBR segment in a message used to order a test may optionally be followed by one or more result (OBX) segments. The characteristic that distinguishes a message used to order a test from other messages containing OBR segments is not the presence or absence of OBX segments, but rather the order result status code field in the OBR segment, which is not present in an original order message, but is always present in other messages concerning an order (see 9.3.10). The optional OBX segments following the OBR segment in a message used to order a test may be used for several purposes: *(1)* The original orderer may transmit OBX segments containing patient data (such as body temperature) which is necessary or pertinent for the interpretation of the test being ordered (such as an EEG recording for cerebral death evaluation). *(2)* The original orderer may specify the CPT-4 modifier -26 in the test/observation ID field of the OBR segment, indicating interpretation of an outside study, and may then transmit the entire study (waveform data and annotations) in OBX segments to the laboratory for review. *(3)* OBX segments may be used when downloading equipment settings, as described in 9.4.

9.3.9 Although NCCLS LIS 5-A does not require that an order message be acknowledged, generally it is good practice to do so. The format of the acknowledgment message is as follows:

```
H     Message header segment
MSA   Message acknowledgment
P     Patient identification segment
OBR   Order segment
OBX   Result segment (optional ERR
         category with error information if
         needed)
L     Message terminator segment
```

9.3.10 The OBR segment in the acknowledgment message may contain additional fields that were not present in the original order. These include the assigned producer (diagnostic service) accession number, the order result status code, the date/time scheduled or the test/observation begin date/time, the technician identity, etc. The order result status codes which are of most use in clinical neurophysiology laboratories are given in Table 9-2.

9.3.11 Not all of the codes listed in Table 9-2 need to be implemented by a given system. Codes **S**, **O**, **X** are likely to be used to acknowledge an original order; codes **D**, **X**, **Y**, **Z** may be used to acknowledge a request to cancel or revise an order; all of the codes may be used in messages which respond to status requests (queries); and codes **C**, **F**, **M**, **P**, **R**, **I** may be used when transmitting results of the study. The order result status code field must be present in all OBR segments other than OBR segments used to order a new test, to download equipment settings, to change a previously transmitted order, or to modify a test in progress; this includes OBR segments in order acknowledgment messages and OBR segments in messages which transmit results spontaneously or in response to a query. This allows a message containing a new or revised order to be distinguished from a message acknowledging an order or transmitting results.

9.3.12 When an order message, a cancel or revise order request, or a query or other request concerning an order or a test ordered causes an order status code of **X**, **Y**, or **Z** to be returned, further information about the error in the form of one or more implementation-dependent error codes and optional error messages may be transmitted in an ERR category result (OBX) segment following the OBR segment (this mechanism is specific to order- or study-related error reporting and allows an error message to be associated with the specific order or study to which it applies; see 9.6 for a discussion of non-order-related error reporting). The observation value field of this category of result segment contains one or more subfields separated by repeat delimiters (~). Each subfield contains one error indication, and consists of two components separated by component delimiters (^). The format of the ERR category result segment is summarized in Table 9-3. The first component is an alphanumeric error code, and the second (optional) component is a text error message. The ERR category result segment error codes and messages are not defined by this Technical Standard.

9.3.13 The following is an example of an order message and the corresponding acknowledgment. In this example, **<CR>** indicates a carriage return character. This example includes orders for an EEG study on one subject, a visual evoked potential study on another subject, and EMG studies (generic code 9586X) on a third subject. These three orders were entered at 09:52:16, 13:25:46, and 15:16:49, respectively, on March 23, 1990, were assigned requestor accession numbers of 5678, 5683, and 5692 on the Neuro system, and were sent in a batch from the Sunnyville Neurologic Clinic computer system (Neuro) to the Sunnyville Neurophysiology Lab computer system (NEULAB) at 15:30:05 on March 23, 1990. The acknowledgment message transmitted from NEULAB to Neuro at 15:30:46 on March 23, 1990 is also given. This message echoes the three orders, but the OBR segments contain, in addition, the producer accession numbers (1234 on system EEG for the first order, 1235 on EEG for the second, and 2314 on system EMG for the third), as well as order result status codes of **S** (test scheduled) and the date/times scheduled (07:45:00, 09:15:00, and 08:15:00, respectively, on March 24, 1990). The results are eventually returned to the requestor in the message given in Appendix C . The use of the message type and trigger event code field (**ORM^O01** for the order, **ORR^O02** for the response) is optional in a NCCLS LIS 5-A message header segment. The use of the security field (**34X96ABE59YW**) is also optional.

Order message (requests three studies on three subjects):

```
 H|^~\&|62378|34X96ABE59YW|Neuro (Sunnyville Neurologic Clinic)|<CR>
A|102 W Main Street^Mail Stop 22A^Sunnyville^IN^66666|ORM^O01|(555)444-2222|<CR>
A||NEULAB (Sunnyville Neurophysiology Lab)|Example|P|E.3|19900323153005<CR>
P|1|4567890&1&M10|4567890&1&M10|3-777-222|Doe^John^Q^Jr^Mr|Deere|19300202|<CR>
A|M|W|511 Third Avenue^Apt 2^Hometown^IN^66667||445-1111Cday~445-2222Cevening<CR>
A||32975^Smith&John&P&III&Dr&MD^UPIN|||160^cm|60^kg|401.9^Hypertension^I9C|<CR>
A|propranolol~diazepam|Last meal 12 hrs ago||Right|19900214|IP|Psych||C|<CR>
A|M|BP|English|PSY|19900214<CR>
OBR|1|5678^Neuro||95816^EEG recording||19900323095216|||||N|^dementia|<CR>
A|^60 year old male with 3 month hx of myoclonus, cognitive decline, and memory <CR>
A|loss|||32975^Smith&John&P&III&Dr&MD|444-3555|||||||EN||||||WHLC<CR>
P|2|4321098&8&M10|4321098&8&M10||Harvey^Jane^J^^Mrs||19600123|F|W|214 First <CR>
A|Street^Apt. 315^Hometown^IN^66667||445-3333Cday~445-4444Cevening|<CR>
```

```
A|53927^Jones&Thomas&L&&Dr&MD|||142^cm|55^kg|||||Right||OP|Neuro|||M||||<CR>
A|19900323<CR>
OBR|1|5683^Neuro||95930^Visual evoked potential study||19900323132546|||||<CR>
A|N||^30 year old female with 2 week hx of blurred vision in right eye. <CR>
A|Rule out multiple sclerosis.|||53927^Jones&Thomas&L&&Dr&MD|444-3666|<CR>
A|||||||EN<CR>
P|3|3321123&6&M10|3321123&6&M10||Newton^Isaac^M^^Mr||19530810|M|W|<CR>
A|567 Center Street^^Pleasantville^IN^66661||441-6666Cday~441-7777Cevening|<CR>
A|42678^Welby&Marcus&L&&Dr&MD^UPIN|||153^cm|74^kg|||||Right~Right||OP|<CR>
A|Neuro|||M||||19900320<CR>
OBR|1|5692^Neuro||9586X^EMG studies||19900323151649|||||N||^36 year old <CR>
A|male with 6 month hx of tingling and pain in thumb, index, and middle <CR>
A|finger of right hand. Rule out carpal tunnel syndrome.|||<CR>
A|42678^Welby&Marcus&L&&Dr&MD|444-2323|||||||EN<CR>
L|1||3|28|62378<CR>
```

Acknowledgment (echoes 3 OBR segments with status **S** and time scheduled):

```
H|^~\&|19183|34X96ABE59YW|NEULAB (Sunnyville Neurophysiology Lab)|<CR>
A|102 W Main Street^Mail Stop 29B^Sunnyville^IN^66666|ORR^O02|(555)444-3333|<CR>
A||Neuro (Sunnyville Neurologic Clinic)|Example|P|E.3|19900323153046<CR>
MSA|AA|62378<CR>
P|1|4567890&1&M10|4567890&1&M10|3-777-222|Doe^John^Q^Jr^Mr|Deere|19300202|<CR>
A|M|W|511 Third Avenue^Apt 2^Hometown^IN^66667||445-1111Cday~445-2222Cevening<CR>
A||32975^Smith&John&P&III&Dr&MD^UPIN|||160^cm|60^kg|401.9^Hypertension^I9C|<CR>
A|Propranolol~diazepam|Last meal 12 hrs ago||Right|19900214|IP|Psych||C|<CR>
A|M|BP|English|PSY|19900214<CR>
OBR|1|5678^Neuro|1234^EEG|95816^EEG recording||19900323095216|||||N|<CR>
A|^dementia|^60 year old male with 3 month hx of myoclonus, cognitive <CR>
A|decline, and memory loss|||32975^Smith&John&P&III&Dr&MD|444-3555|||||||EN|<CR>
A|S|||||WHLC||||||19900324074500<CR>
P|2|4321098&8&M10|4321098&8&M10||Harvey^Jane^J^^Mrs||19600123|F|W|214 First <CR>
A|Street^Apt. 315^Hometown^IN^66667||445-3333Cday~445-4444Cevening|<CR>
A|53927^Jones&Thomas&L&&Dr&MD|||142^cm|55^kg|||||Right||OP|Neuro|||M||||<CR>
A|19900323<CR>
OBR|1|5683^Neuro|1235^EEG|95930^Visual evoked potential study||<CR>
A|19900323132546|||||N||^30 year old female with 2 week hx of <CR>
A|blurred vision in right eye. Rule out multiple sclerosis.|||<CR>
A|53927^Jones&Thomas&L&&Dr&MD|444-3666|||||||EN|S|||||||||||19900324091500<CR>
P|3|3321123&6&M10|3321123&6&M10||Newton^Isaac^M^^Mr||19530810|M|W|<CR>
A|567 Center Street^^Pleasantville^IN^66661||441-6666Cday~441-7777Cevening|<CR>
A|42678^Welby&Marcus&L&&Dr&MD^UPIN|||153^cm|74^kg|||||Right~Right||OP|<CR>
A|Neuro|||M||||19900320<CR>
OBR|1|5692^Neuro|2314^EMG|9586X^EMG studies||19900323151649|||||N||<CR>
A|^36 year old male with 6 month hx of tingling and pain in thumb, index, <CR>
A|and middle finger of right hand. Rule out carpal tunnel syndrome.|||42678^<CR>
A|Welby&Marcus&L&&Dr&MD|444-2323|||||||EN|S|||||||||||19900324081500<CR>
L|1||3|30|19183<CR>
```

9.4 *Downloading of Equipment Settings*—This Technical Standard provides a means by which a higher-level machine within a laboratory (such as an EEG data acquisition station) may transmit equipment settings to a lower-level machine (such as an intelligent multichannel amplifier) while sending it an order instructing it to prepare for a particular study. Examples of this downloading process include sending montage, channel, and electrode data, measured distances, or a stimulation program (for example, for photic stimulation). Communication of equipment settings or other control information may also occur while a study is in progress. For example, one machine within the laboratory (such as an EEG review station) may be able to remotely control the operation of another machine (such as an EEG data acquisition station) while a study is in progress. Downloading and other remote control operations are accomplished by sending a message from one machine to another. This section describes the use of the OBR and OBX segments to accomplish one type of remote control. Other remote control operations which use the Q segment are described in 9.5.20.

9.4.1 The format of a NCCLS LIS 5-A message used to initiate an electrophysiologic test and download equipment settings, or to modify or remotely control the settings of an instrument while a test is in progress, is as follows:

```
H          Message header segment
P          Patient identification segment
OBR        Order segment
OBX        Result segment
...
L          Message terminator segment
```

9.4.2 When used to initiate a new electrophysiologic test and download equipment settings, the OBR segment contains all of the information needed to initiate (order) the test as described in 9.3. In fact, the OBR segment may be a modified copy of the OBR segment transmitted to the laboratory from an external computer system when electronically ordering the test. Since the message used for downloading equipment settings is intended to be used primarily between electrophysiologic instruments within a particular laboratory, it is not necessary to duplicate the fields of the original OBR segment that contain information (such as clinical data) which is not relevant to the receiving instrument. However, all R1-required fields in the OBR segment must be present. The order action code (Table 9-1) should be **N** (new order) or **G** (new generated order), and the order result status code (Table 9-2) should be omitted (not present). The OBX segments following the OBR segment contain the equipment settings to be downloaded.

9.4.3 When used to modify or remotely control settings or other aspects of processing for an electrophysiologic test in progress, the OBR segment may also be a modified copy of the OBR segment used originally to initiate the test. As for downloading, it may not be necessary to duplicate the fields of the original OBR segment that contain unnecessary information, but all R1-required fields in the OBR segment must be present. The order action code must be **R** (revise order), and the order result status code should be omitted (not present). The OBX segments following the OBR segment contain the equipment settings to be modified or other information needed to remotely control the instrument.

9.4.4 The OBX segments that follow the OBR segment determine the action taken by the receiver. The most commonly used categories of OBX segments are given in 9.4.4.1 through 9.4.4.7. An instrument need not implement the capability to accept all (or any) types of downloaded equipment settings. Similarly, an instrument need not implement the capability to accept all (or any) types of equipment setting modification or remote control requests. This standard merely specifies the mechanism by which downloading or remote control may be accomplished in systems or installations that need these facilities.

9.4.4.1 To download montage data (electrode or channel definitions, or both) at the start of a study or to modify montage data during a study, MTG, ELC, CHN, and optionally SEL category OBX segments are used. Zero or more ELC category OBX segments are first transmitted to define the common electrode set if necessary (see 6.1.5). Then, one or more MTG category OBX segments are transmitted (one for each montage to be downloaded), each followed by zero or more ELC category OBX segments (defining electrodes for that montage) and zero or more CHN category OBX segments (defining channels). If a MTG category OBX segment that specifies a previously defined montage number is transmitted, the previously defined electrode and channel definitions for that montage are put into effect. This is especially useful when modifying montage data during a study. SEL category result segments may also be transmitted after the montages have been defined, to specify that certain montages are to be selected for particular functions such as waveform display or printing.

9.4.4.2 To download measured distances at the start of a study or during a study, one or more DST category OBX segments are used. These DST category OBX segments may then be incorporated into a later message containing test results (including a message defining waveform data transmitted in real time) or may be used to calculate derived numeric quantities such as conduction velocities.

9.4.4.3 To download a stimulation program at the start of a study or during a study, STM and TIM category OBX segments are used. Each TIM category OBX segment observation value field contains a single component that specifies the time (relative to the start of the stimulation program) at which a stimulus is delivered, begins, or ends; the TIM category OBX segment is followed by one or more STM category OBX segments defining the stimulus (or stimuli) which are delivered, begin, or end at that time. It is not necessary to transmit a TIM category OBX segment before a STM category OBX segment when downloading only stimulus information (such as intensity or duration) to an instrument during initiation of a study (for example, if the times at which the stimuli were to be delivered were predetermined, or defined later by the receiving instrument). Also, if a STM category OBX segment is transmitted without a preceding TIM category OBX segment after an OBR segment with action code **R**, an instrument receiving the message may interpret this as a command to deliver, begin, or end the specified stimulus at the time the message is received.

9.4.4.4 To download technical comments concerning observations made or history obtained at the start of a study, one or more TCM category OBX segments are sent in a message following an OBR segment with action code **N** or **G**. These TCM category OBX segments may then be incorporated into a later message containing test results, preceding the waveform data for the study. Also, to transmit a technical comment concerning the study (other than an annotation to the waveform data) while the study is in progress, one or more TCM category OBX segments are sent in a message following an OBR segment with action code **R**. These TCM category OBX segments may then be incorporated into a later message containing test results (including a message defining waveform data transmitted in real time).

9.4.4.5 To download information about medications given at the start of a study, one or more MED category OBX segments are sent in a message following an OBR segment with action code **N** or **G**. These MED category OBX segments may then be incorporated into a later message containing test results, preceding the waveform data for the study. Also, to transmit information about medications given while a study is in progress, one or more MED category OBX segments are sent in a message following an OBR segment with action code **R**. These MED category OBX segments may then be incorporated into a later message containing test results (including a message defining waveform data transmitted in real time). In some implementations, they may also be interpreted as an instruction to the technician to administer the specified medication to the subject.

9.4.4.6 To transmit annotations to waveform data such as observations of the subject's behavior, or analyses performed on epochs of waveform data while a study is in progress, one or more ANA category OBX segments are sent in a message following an OBR segment with action code **R**. These ANA category OBX segments may then be incorporated into a later message containing test results (including a message defining waveform data transmitted in real time) merged with the appropriate WAV-category OBX segments. In some implementations, they may also be interpreted as an instruction to display annotations or analysis results along side the waveform data for the benefit of the technician running the test. When appropriate, the ANA category OBX segment can specify the date/time and duration of the annotation or analyzed data.

9.4.4.7 To download sampling intervals, epoch durations, transmitted data formats, or averaging parameters at the start of a study or to modify these parameters during a study, one or more TIM category OBX segments containing the appropriate data are transmitted in a message following an OBR segment with an appropriate action code (**N**, **G**, or **R**). The first component of the observation value field of these TIM category OBX segments is omitted.

9.4.5 A message used to order or initiate an electrophysiologic test and download equipment settings, or a message used to modify or remotely control settings for a study in progress, should be acknowledged using the format specified in 9.3.9. The OBR segment order result status codes described in 9.3.10 are used in the acknowledgment message, and error information (in the case of an invalid request or unimplemented function) may be returned as described in 9.3.12.

9.4.6 The following are examples of download request messages and the corresponding acknowledgment messages. In these examples, **<CR>** indicates a carriage return character.

9.4.6.1 Example of a request to initiate an EEG study, specifying montage channel information:

Order message (requests a study and specifies channels in montage 1):

```
H|^~\&|53424||EEGS1|||||EEGA1||P|E.3|19920723122542<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||||||N|^dementia|<CR>
A|^62 year old male with 3 month hx of myoclonus, cognitive decline, and <CR>
A|memory loss|||32975^Smith&John&P&III&Dr&MD|444-3555<CR>
OBX|1|CM|95816&MTG^EEG recording|1|1&LR-21.1 (A1/2)^21<CR>
OBX|2|CM|95816&CHN^EEG recording|1|1^Fp1&Av^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&70&6~2^Fp2&Av^^1.015&0~3^F3&Av^^0.983&0~4^F4&Av^^<CR>
A|1.005&0~5^C3&Av^^0.964&1~6^C4&Av^^0.993&0~7^P3^Av^^0.989&0~8^P4&Av^^<CR>
A|1.013&0~9^O1&Av^^1.106&0~10^O2&Av^^0.992&2~11^F7&Av^^<CR>
A|0.987&0~12^F8&Av^^1.002&0~13^T3&Av^^1.076&-1~14^T4&Av^^<CR>
A|1.112&0~15^T5&Av^^0.988&0~16^T6&Av^^1.087&0~17^Fpz&Av^^<CR>
```

```
A|0.992&0~18^Fz^Av^^1.135&0~19^Cz&Av^^0.988&0~20^Pz&Av^^<CR>
A|1.103&0~21^Oz&Av^^0.998&0<CR>
L|1||1|15|53424<CR>
```

Acknowledgment (echoes OBR segment with status **I**):

```
H|^~\&|22789||EEGA1|||||EEGS1||P|E.3|19920723122657<CR>
MSA|AA|53424<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||19920723122606||||N|<CR>
A|^dementia|^62 year old male with 3 month hx of myoclonus, cognitive <CR>
A|decline, and memory loss|||32975^Smith&John&P&III&Dr&MD|444-3555||||||||<CR>
A|I|||||||||^Sullivan&Joyce&D&&Ms<CR>
L|1||1|8|22789<CR>
```

9.4.6.2 Example of a request to initiate an EEG study, downloading a stimulus program; the stimulus program specifies flash visual stimulation to both eyes at rates 3 Hz from 0 to 10 s, 10 Hz from 15 to 25 s, and 20 Hz from 30 to 40 s after the start of the program:

Order message (requests a study and specifies stimulus program):

```
H|^~\&|53425||EEGS1|||||EEGA1||P|E.3|19920723122542<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording||||||N<CR>
OBX|1|CM|95816.31&TIM^EEG recording, during photic stimulation|1|<CR>
A|00000000000000.000<CR>
OBX|2|CM|95816.31&STM^EEG recording, during photic stimulation|1|<CR>
A|BEGIN^FLS^T-XX000-BIL&bilateral eye^3^0.00001^22^cd.s/m2^WHT<CR>
OBX|3|CM|95816.31&TIM^EEG recording, during photic stimulation|2|<CR>
A|00000000000010.000<CR>
OBX|4|CM|95816.31&STM^EEG recording, during photic stimulation|2|<CR>
A|END^FLS^T-XX000-BIL&bilateral eye^3^0.00001^22^cd.s/m2^WHT<CR>
OBX|5|CM|95816.31&TIM^EEG recording, during photic stimulation|3|<CR>
A|00000000000015.000<CR>
OBX|6|CM|95816.31&STM^EEG recording, during photic stimulation|3|<CR>
A|BEGIN^FLS^T-XX000-BIL&bilateral eye^10^0.00001^22^cd.s/m2^WHT<CR>
OBX|7|CM|95816.31&TIM^EEG recording, during photic stimulation|4|<CR>
A|00000000000025.000<CR>
OBX|8|CM|95816.31&STM^EEG recording, during photic stimulation|4|<CR>
A|END^FLS^T-XX000-BIL&bilateral eye^10^0.00001^22^cd.s/m2^WHT<CR>
OBX|9|CM|95816.31&TIM^EEG recording, during photic stimulation|5|<CR>
A|00000000000030.000<CR>
OBX|10|CM|95816.31&STM^EEG recording, during photic stimulation|5|<CR>
A|BEGIN^FLS^T-XX000-BIL&bilateral eye^20^0.00001^22^cd.s/m2^WHT<CR>
OBX|11|CM|95816.31&TIM^EEG recording, during photic stimulation|6|<CR>
A|00000000000040.000<CR>
OBX|12|CM|95816.31&STM^EEG recording, during photic stimulation|6|<CR>
A|END^FLS^T-XX000-BIL&bilateral eye^20^0.00001^22^cd.s/m2^WHT<CR>
L|1||1|28|53425<CR>
```

Acknowledgment (echoes OBR segment with status **I**):

```
H|^~\&|22790||EEGA1|||||EEGS1||P|E.3|19920723122654<CR>
MSA|AA|53425<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||19920723122606||||N|<CR>
A||||||||||||||I<CR>
L|1||1|6|22790<CR>
```

9.4.6.3 Example of a request to add an annotation to the waveform data during an EEG study in progress; the system receiving the request is unable to comply:

Revise order message (specifies annotation to be added):

```
H|^~\&|53426||EEGS1|||||EEGA1||P|E.3|19920723122702<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||||||R<CR>
OBX|1|TX|95816.0101&ANA|1|&MAN&MOVE&&&Moves<CR>
L|1||1|5|53426<CR>
```

Acknowledgment (echoes OBR segment with status **X**):

```
H|^~\&|22791||EEGA1|||||EEGS1||P|E.3|19920723122715<CR>
MSA|AA|53426<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||||||R||||||||||||||X<CR>
OBX|1|CM|95816&ERR^EEG recording|1|993^Requested remote control operation <CR>
A|is not available on this system<CR>
L|1||1|7|22791<CR>
```

9.5 *Request (Query) Functions*—This Technical Standard, in keeping with NCCLS LIS 5-A and HL7, provides a means by which one system may request the status of or results from a previously ordered test from another system. This *solicited* transmission of results is an alternative to an *unsolicited* transmission of results.

9.5.1 In addition, this Technical Standard extends the request or query capabilities of NCCLS LIS 5-A to include various functions necessary for communication of control, waveform, and report data between cooperating machines within a laboratory.

9.5.2 The format of a NCCLS LIS 5-A message used to make a request or query is as follows:

```
H    Message header segment
Q    Request results segment
L    Message terminator segment
```

9.5.3 The NCCLS LIS 5-A Q segment specifies one or more requestor assigned patient IDs (field 3) and one or more producer assigned patient IDs (field 4; may be the same as field 3) as a means of identifying particular patients. It also specifies one or more test/observation IDs in field 5 as a means of identifying particular tests to which the query applies. For queries that do not involve a specific test and patient, these fields may not be present or they may contain the keyword **ALL** when results for all patients or all tests are desired.

9.5.4 The Q segment also may specify the requesting physician in field 9 and the requesting physician telephone number in field 10. These fields may not be present if the requesting physician is not known or not relevant.

9.5.5 The Q segment optionally specifies the beginning and ending request results date/time in fields 7 and 8, and the nature of request time limits in field 6. A single date/time is encoded in field 7. A range of date/times is encoded in field 7 (beginning request results date/time) and field 8 (ending request results date/time). A series of individual date/times are encoded in field 7, separated by repeat delimiters. Field 6 indicates whether the date/times in fields 7 and 8 refer to the date/times of the start of the studies (field 6 = **S**) or to the date/times of the reports as encoded in OBR segment field 23 (field 6 = **R**). The date/times in fields 7 and 8 may be used when it is desired to restrict the results returned in response to a query to specific dates and times; if no beginning date/time is present, the queried system should assume that results going back as far into the past as is possible are desired, and if no ending date/time is present, that results up to the present time are desired.

9.5.6 This Technical Standard permits field 12 (requestor special field 2) of the Q segment to serve the function of the HL7 specification QRD segment *what subject filter* field. It specifies the nature of the query being made (that is, the type of information required to satisfy the request).

9.5.7 Requestor special field 2 (subject filter and qualifiers) of the Q segment is a multicomponent field. The first component (the subject filter code) determines the type of request or query. The subsequent components of this field are optional qualifiers to the subject filter code. The number and meaning of these components depend on the choice of subject filter code. Table 9-4 lists the available request types, the appropriate subject filter codes, and the optional qualifiers for each.

9.5.8 In Table 9-4, *com.ID* represents a communication channel identifier, an alphanumeric string that has meaning to both the sending and the receiving system and which identifies a particular communication channel by which the two systems may exchange messages. Also, *dev.ID* represents a device identifier, an alphanumeric string that has meaning to both the sending and receiving system and which identifies a particular device (disk, tape, printer, or display) on the system to whom the message is addressed. In addition, *d/c.ID* represents either a device or a communication channel identifier, depending on the specific function involved. Furthermore, *acc.num* represents a producer (diagnostic service) accession number (as used in OBR segment field 4), which uniquely identifies the test or order to which the request applies. Of the two components in OBR segment field 4, only the first component (the laboratory assigned study number) is used in the query request, since the second component (the producer application identifier) is known by context. Also, *mtg.num* represents a montage number (as given in a MTG category result segment), *dat.typ* is a keyword specifying the type and level of detail of montage data, and *seg.num* represents a result (OBX) segment sequence number (field 2 in an OBX segment). Finally, *file.ID* represents a file identifier, an alphanumeric string that has meaning to both the sending and receiving system and which identifies a particular data file on a device on the system to whom the message is addressed. The communication channel, device, and file identifiers may or may not be the actual *internal* names used by the target system; for example, in some implementations the specified identifiers may be modified for internal use (for example, by concatenation with a patient ID to make them unique, or by appending directory path names to file names).

9.5.9 Also in Table 9-4, *func.ID* identifies a particular function that can be or is being performed by the system to whom the message is addressed. Table 9-5 shows a list of identifiers for functions that may commonly be performed by systems in a clinical neurophysiology laboratory; alternatively, other function identifiers may be used which have meaning to both the sending and the receiving system. In this table, *waveform data* includes both digitized waveform data itself and all related annotations (such as technical comments, stimulation data, annotations or analyses, etc.) other than the final reports that are generated later on review of the waveforms and which may be sent back to the ordering service. *Report data* includes the latter reports. The distinction between waveform data and reports is necessary because some systems may be capable only of handling reports, while others may only handle waveform data. Thus, for example, a system that could print both waveform data and reports would show both **WPR** and **RPR** as available functions. However, in some implementations (as agreed upon by the two communicating systems), some of the *waveform only* functions (**WDI, WPR, WTM, WRC, WST, WAR, WRE**) may be used to indicate display, printing, transmission, reception, storage, archival, or retrieval of both waveform and report data as a single unit. The **DEM** function indicates that the system stores locally or has access to a patient demographic data base and can respond to a **DEM** request. The **ORD** function indicates that the system provides an electronic ordering function and can send orders for tests to other systems, or respond to an **ORD** request. The **ORN** function indicates that the system receives or generates new orders for tests and assigns unique producer (diagnostic service) accession numbers to the orders or tests and can respond to an **ORN** request. The **OMD** function indicates that the system stores locally or has access to test/observation master data and can respond to an **OMD** request. The **MTG** function indicates that the system stores locally or has access to a collection of predefined montages for general use (with electrode and channel definitions) and can respond to a **MTG** request that specifies **ALL** in the patient ID field.

9.5.10 *System Status, Configuration, and Capability Queries*—These queries are used to obtain information about another system. A system that implements two-way communication need only implement those system queries which are needed for communication among cooperating systems in a laboratory; however, it is suggested that at least the *system time, system ID, system availability*, and *last error code/message* queries be implemented in most two-way communication implementations.

9.5.10.1 A number of the system queries (such as *system communications*, *system storage devices*, and *system display devices*) return implementation-dependent information (that is, information which depends on the hardware configuration, operating system, and communication software of the queried system). These system queries should therefore only be used if necessary for a given application, since use of these queries is, in general, non-portable and nonstandard. Since system queries do not return data specific to individual patients or orders, the patient ID and test/observation ID fields in the query segment are not present, and the beginning and ending date/time fields are not present for these queries.

9.5.10.2 When a message containing a system status, configuration, or capability query is received by the destination system, it responds by sending a message back to the requesting system. The format of a NCCLS LIS 5-A query response message is as follows:

```
H       Message header segment
MSA     Message acknowledgment segment
L       Message terminator segment
```

9.5.10.3 The answer to the query is contained in the text message field (field 4) of the MSA segment. The following describes the various types of system status queries and the data which is returned to the requestor in response to each of these types.

9.5.10.4 The **STI** (*system time*) request returns the current clock time (in TS data format, generally with fractional seconds included). This request may be used to facilitate synchronization of clocks in multiple systems. For example, one system could be used as a *master* clock, while other systems would query it and set their clocks accordingly. It may also be used merely as an *are you there?* query, to determine if the system queried is able to respond.

9.5.10.5 The **SID** (*system identification*) request returns an identification of the queried system as a composite field with up to five components, separated by component delimiters (^). The first component is the manufacturer company name. The second component is the manufacturer-assigned product name. The third component is the model number. The fourth component is the software version number. The fifth component is the serial number. The format and length of each component are implementation-dependent. Only as many components as are known and relevant need be returned.

9.5.10.6 The **SAV** (*system availability*) request returns an indication of the availability of the queried system for performing electroneurophysiologic tests. Possible answers are **R** (ready), **B** (busy), or **O** (off line). **R** indicates that the system is ready to begin a new test. For a system that can only perform one test at a time, **B** indicates that it is currently performing a test. For a system that can perform more than one test concurrently (for example, a system which can acquire EEG data from up to four subjects), **B** indicates that the system is currently performing as many concurrent tests as it is able. **O** indicates that the system is able to receive and respond to messages but is currently not able to perform tests.

9.5.10.7 The **SFN** (*system functions*) request returns a list of all functions which may be performed by the queried system. The possible system function identifiers are given in Table 9-5, although other identifiers may also be used which have meaning to both the querying and queried system. When multiple function identifiers are returned, they are separated by repeat delimiters (~).

9.5.10.8 The **SCM** (*system communications*) request has a single optional qualifier, which is a communication channel identifier. This identifier may be **ALL** (the default) to indicate that the queried system should return a list of all available communication channels and their characteristics, or it may specify a particular communication channel whose characteristics are to be returned. When multiple communication channels are returned as a list, they are separated from each other by repeat delimiters (~). Each communication channel in the list (or the single communication channel requested by name) consists of a set of three components, separated by component delimiters (^). The first component is either a communication protocol (for network communication channels) or a parity and baud rate designation (for serial line communication channels). Examples of these are given in Table 9-6; alternatively, other communication protocol or parity/baud rate codes which have meaning to the sending and receiving system may be used. The second component is a code designating the type of network or serial line used. Examples are given in Table 9-7; alternatively, other codes which have meaning to the sending and receiving system may be used. The third component is the communication channel identifier (a name which identifies the particular communication channel); the allowed values are implementation-dependent. In some implementations, generic communication channel identifiers may be used to specify a particular class of communication channels, of which more than one is available; for example, **NET** may be a generic name for three communication channels called **NET1, NET2**, and **NET3**. A generic name should be returned in response to a **SCM** request only if it is permissible to use that generic name for the communication channel in a later **BEG** request. An example of communication channel data is **N96^R232^COM1** (no parity, 9600 baud, RS232 serial line, called **COM1**).

9.5.10.9 The **SDV** (*system storage devices*) request has a single optional qualifier, which is a device identifier. This identifier may be **ALL** (the default) to indicate that the queried system should return a list of all available storage devices and their characteristics, or it may specify a particular storage device whose characteristics are to be returned. When multiple storage devices are returned as a list, they are separated from each other by repeat delimiters (~). Each storage device in the list (or the single storage device requested by name) consists of a set of five components, separated by component delimiters (^). The first component is a device type. Examples of device type codes are given in Table 9-8; alternatively, other device type codes which have meaning to the sending and receiving system may be used. The second component is a device identifier (a name which identifies the particular storage device); the allowed values are implementation-dependent. In some implementations, generic device identifiers may be used to specify a particular class of devices, of which more than one is available; for example, **DD** may be a generic name for three storage devices called **DD1, DD2**, and **DD3**. A generic name should be returned in response to a **SDV** request only if it is permissible to use that generic name for the storage device in a later **BEG** request. The third component is a storage device status code; this may be **R** (device ready), **O** (device off line), or **B** (device busy—used for devices that cannot be shared and which are currently in use). The fourth (optional) component is the available storage space on the device, in the form **<number><units>**, where **<number>** is a positive number with an optional decimal fraction, and **<units>** is a single letter: **B** for bytes, **K** for kilo (1024) bytes, **M** for mega (1048576) bytes, or **G** for giga (1073741824) bytes. The fifth (optional) component is the total storage space on the device, in the same format. An example of storage device data is **OD^DO2^R^1.445G^2G** (optical disk drive called **DO2**, ready, available space 1.445 gigabytes, total space 2 gigabytes).

9.5.10.10 The **SPD** (*system printer/display devices*) request has a single optional qualifier, which is a device identifier. This identifier may be **ALL** (the default) to indicate that the queried system should return a list of all available printer/display devices and their characteristics, or it may specify a particular printer/display device whose characteristics are to be returned. When multiple printer/display devices are returned as a list, they are separated from each other by repeat delimiters (~). Each printer/display device in the list (or the single printer/display device requested by name) consists of a set of three components, separated by component delimiters (^). The first component is a device type. Examples of device type codes are given in Table 9-8; alternatively, other device type codes which have meaning to the sending and receiving system may be used. The second component is a device identifier (a name which identifies the particular printer/display device); the allowed values are implementation-dependent. In some implementations, generic device identifiers may be used to specify a particular class of devices, of which more than one is available; for example, **PRN** may be a generic name for two printers called **PRN1** and **PRN2**. A generic name should be returned in response to a **SPD** request only if it is permissible to use that generic name for the printer/display device in a later **BEG** request. The third component is a printer/display device status code; this may be **R** (device ready), **O** (device off line), or **B** (device busy—used for devices that cannot be shared and which are currently in use). An example of printer/display device data is **MP^LPT1^R** (monochrome sheet printer called **LPT1**, ready).

9.5.10.11 The **ERR** (*last error code/message*) request may be used when a transmitting system needs to receive a repeat transmission of the last error message which (as described in 9.6) may be sent by a receiving system in response to a message which cannot be processed because of a syntax or unrecoverable transmission error. The error message sent in response to the erroneous message and the one sent in response to the **ERR** query have identical formats. The error data returned consists of the text string **ERR** followed by an error code and optional additional error message (explanatory text) in the text message field of an MSA segment in the response message. The acknowledgment code (field 2) of the MSA segment contains **AA** (application accept) rather than **AE** (application error) as in the original error message, indicating successful completion of the query request.

9.5.10.12 The **DTY** (*data types*) request returns a list of the types of result data which may be handled by the queried system. The possible result data types are given in Table 9-9. When multiple result data types are returned, they are separated by repeat delimiters (~). **WAVE, ANNO**, and **RPRT** refer to common groupings of information categories of result segments. For example, a Level I implementation of this Technical Standard would handle only type **WAVE** data, a Level II implementation might handle type **WAVE, ANNO**, and **RPRT** data, and a hospital result inquiry system might handle only type **RPRT** data. **CODE** and **TEXT** refer to the way coded entry results (such as ANT, IMP, REC, and type CE null category results) are treated. **TEXT** by itself indicates that codes are ignored (receiver systems) or not transmitted (transmitter systems). **CODE** by itself indicates that text descriptions of codes are not required but, when absent, may be automatically generated from the code (receiver systems), and are not transmitted unless no equivalent code exists (for transmitter systems). If both **TEXT** and **CODE** are returned, the system queried will automatically generate text descriptions, if absent, from codes (receiver systems), but will transmit both codes and text, even when they are equivalent (transmitter systems). Examples of result data type lists returned by this query are: **WAVE~TEXT** (Level I); **WAVE~ANNO~RPRT~TEXT** (Level II); **WAVE~ANNO~RPRT~CODE** or **WAVE~ANNO~RPRT~TEXT~CODE** (Level III).

9.5.10.13 The **DLM** (*data limits*) request returns the various implementation-determined maximum limits of the queried system as a composite field with up to seven components, separated by component delimiters (^). The first component is the maximum number of channels allowed in waveform data. The second component is the maximum number of montages which may be defined. The third component is the maximum number of electrodes for any montage. The fourth component is the maximum number of elements which may be defined for any physical electrode. The fifth component is the maximum number of electrodes which may contribute to any derived electrode. The sixth component is the maximum number of filters which may be defined for any single channel. The seventh component is the maximum number of analysis parameters which may be used. Only as many of these components as are known and relevant need be returned. Each component is a positive decimal integer.

9.5.10.14 The **DFO** (*data formats*) request returns a list of the formats of waveform data which may be handled by the queried system. The possible waveform data formats are given in Table 6-15, although other formats may also be used which have meaning to both the querying and queried system. When multiple waveform data formats are returned, they are separated by repeat delimiters (~).

9.5.10.15 The **DFR** (*data sample frequencies*) request returns a list of the sampling frequencies for waveform data which may be handled by the queried system. Each item in the list may consist of a single frequency in hertz (a positive decimal integer, or zero to indicate sporadic sampling, as described in 6.4.5), or it may be a pair of frequencies separated by component delimiters (^) to indicate a range (lowest frequency of range, then highest frequency). When multiple data sampling frequencies are returned, they are separated by repeat delimiters (~). An example is **25~50~100^200~500**, which indicates that sampling frequencies of 25 Hz, 50 Hz, 100 to 200 Hz, and 500 Hz are allowed.

9.5.11 The following are examples of query messages and the corresponding responses. In these examples, **<CR>** indicates a carriage return character.

9.5.11.1 Example of a system identification query:

Query (requests system identification):

```
H|^~\&|32356||EEGS1 (EEG storage system)|||||EEGA1 (EEG data acquisition)|<CR>
A||P|E.3|19920723122514<CR>
Q|1||||||||||SID<CR>
L|1||0|4|32356<CR>
```

Response (returns system identification):

```
H|^~\&|12396||EEGA1 (EEG data acquisition)|||||EEGS1 (EEG storage system)||<CR>
A|P|E.3|19920723122542<CR>
MSA|AA|32356|Acme EEG^Blazer^BL-34^4.5^10334572<CR>
L|1||0|4|12396<CR>
```

9.5.11.2 Example of a system communications query:

Query (requests characteristics of communication channel **NET5**):

```
H|^~\&|32357||EEGS1 (EEG storage system)|||||EEGR1 (EEG review system)|<CR>
A||P|E.3|19920723123119<CR>
Q|1||||||||||SCM^NET5<CR>
L|1||0|4|32357<CR>
```

Response (returns characteristics of **NET5**):

```
H|^~\&|18244||EEGR1 (EEG review system)|||||EEGS1 (EEG storage system)||P|<CR>
A|E.3|19920723123148<CR>
MSA|AA|32357|TCP^ENET^NET5<CR>
L|1||0|4|18244<CR>
```

9.5.11.3 Example of a data sample frequencies query:

Query (requests available data sample frequencies):

```
H|^~\&|12397||EEGA1|||||EEGR1||P|E.3|19920723135736<CR>
Q|1||||||||||DFR<CR>
L|1||0|3|12397<CR>
```

Response (returns available data sample frequencies):

```
H|^~\&|18245||EEGR1|||||EEGA1||P|E.3|19920723135805<CR>
MSA|AA|12397|200~400~1000<CR>
L|1||0|3|18245<CR>
```

9.5.11.4 Example of a system storage devices query:

Query (requests characteristics of storage device **D2**):

```
H|^~\&|32358||EEGS1|||||Neuro||P|E.3|19920723141545<CR>
Q|1||||||||||SDV^D2<CR>
L|1||0|3|32358<CR>
```

Response (returns characteristics of **D2**):

```
H|^~\&|47234||Neuro|||||EEGS1||P|E.3|19920723141557<CR>
MSA|AA|32358|OD^D2^R^1.445G^2G<CR>
L|1||0|3|47234<CR>
```

9.5.12 *Master Database Search Requests*—These queries are used to obtain detailed test/observation (**OMD**) or patient demographic (**DEM**) information from a database stored on (or accessible from) another system, or to obtain a list of patients (**DEM**) currently known to another system. It is expected that only some systems that implement two-way communication will respond to these requests with complete test or patient demographic data (for example, only certain designated systems which act as database servers or as gateway machines to database servers). Other machines which cooperate in performing electroneurophysiologic tests may wish to implement only the **DEM** query in a limited fashion (returning only a list of patients whose tests are in progress or whose data are on file, but omitting all other demographic information).

9.5.12.1 In the **OMD** request, the test/observation ID field of the Q segment contains the identifier of the test or observation about which data are desired; the keyword **ALL** (which is the default if not present) indicates that data are needed concerning all tests or observations that the laboratory can perform. The patient ID fields are omitted for this request. In the **DEM** request, the patient ID fields of the Q segment identify the particular patient whose demographic data are desired; the keyword **ALL** (which is the default if not present) indicates that demographic data on all known patients are needed. The test/observation ID field is omitted for this request. Since database search requests do not return data specific to particular dates or times, the beginning and ending date/time fields are not present for these queries. When a message containing an **OMD** request is received by the destination system, it responds by sending a message back to the requesting system which contains one or more OM1, OM2, OM3, OM4, OM5, or OM6 (test/observation master) segments describing the tests or observations performed by the laboratory. The OM1-OM6 segments are defined in NCCLS 5-A. When a message containing a **DEM** request is received by the destination system, it responds by sending a message back to the requesting system which contains one or more P (patient identifying) segments.

9.5.12.2 The format of a NCCLS LIS 5-A query response message is as follows:

```
H          Message header segment
MSA        Message acknowledgment segment
OMx or P   Test/observation master or patient identifying segment 1
OMx or P   Test/observation master or patient identifying segment 2
⋮
L          Message terminator segment
```

9.5.13 The following are examples of query messages and the corresponding responses. In these examples, **<CR>** indicates a carriage return character.

9.5.13.1 Example of a patient list query:

Query (requests list of patients known to system EEGS1):

```
H|^~\&|92645||EEGR1 (EEG review system)|||||EEGS1 (EEG storage system)|<CR>
A||P|E.3|19920723122514<CR>
Q|1|ALL|||||||||DEM<CR>
L|1||0|4|92645<CR>
```

Response (returns list of patients known to system EEGS1):

```
H|^~\&|53285||EEGS1 (EEG storage system)|||||EEGR1 (EEG review system)|<CR>
A||P|E.3|19920723122542<CR>
MSA|AA|92645<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr<CR>
P|2|4321098&8&M10|4321098&8&M10||Harvey^Jane^J^^Mrs<CR>
L|1||2|6|53285<CR>
```

9.5.13.2 Example of a patient demographic data query:

Query (requests demographic data on patient with ID 4567890):

```
H|^~\&|37463||EEGS1|||||Neuro||P|E.3|19920723141545<CR>
Q|1|4567890|4567890||||||||DEM<CR>
L|1||0|3|37463<CR>
```

Response (returns demographic data on patient 4567890):

```
H|^~\&|67487||Neuro|||||EEGS1||P|E.3|19920723141557<CR>
MSA|AA|37463<CR>
P|1|4567890&1&M10|4567890&1&M10|3-777-222|Doe^John^Q^Jr^Mr|Deere|19300202|<CR>
A|M|W|511 Third Avenue^Apt 2^Hometown^IN^66667||445-1111Cday~445-2222Cevening<CR>
A||32975^Smith&John&P&III&Dr&MD^UPIN|||160^cm|60^kg|401.9^Hypertension^I9C|<CR>
A|Propranolol~diazepam|Last meal 12 hrs ago||Right|19920714|IP|Psych||C|<CR>
A|M|BP|English|PSY|19920714<CR>
L|1||1|8|67487<CR>
```

9.5.14 *Requests for Orders*—The *get orders* (**ORD**) request is used when a system wishes to obtain new orders for electroneurophysiologic tests (for example, when it has completed processing a previous order, or when an operator specifies that a subject has arrived and is ready for testing). Orders for a single patient or for all patients and for a single test or for all tests may be requested. The *generate new order* (**ORN**) request is used when a system wishes to initiate a study on a patient for which no order has been received and needs to obtain a unique producer accession number for the generated order from another system. The **ORN** request is only used in NCCLS LIS 5-A format messages, since HL7 provides another mechanism using **SN** (send filler number) in the order control field of the ORC (common order) segment (see the HL7 specification). See 9.3.1 through 9.3.3 for some examples of the use of these requests. These requests need only be implemented in those systems that need to solicit the transmission of new orders; they are not needed in systems that rely on unsolicited order messages alone. For the **ORD** and **ORN** requests, the patient ID fields of the Q segment identify the patient for whom an order is needed; for the **ORD** (but not **ORN**) request, the keyword **ALL** (which is the default if not present) indicates that orders for all patients are needed. Also, the test/observation ID field of the Q segment contains the identifier of the test for which an order is needed; for the **ORD** (but not **ORN**) request, the keyword **ALL** (which is the default if not present) indicates that orders for all tests are needed. If only orders placed on a particular date and time or a range of dates and times are required in a **ORD** request, the beginning and ending date/time fields may be included to specify the desired dates and times. When a message containing an **ORD** request is received by the destination system, it responds by sending a message back to the requesting system which contains one or more P segments, each followed by a group of one or more OBR segments, in the format described in 9.3.4 (except that an MSA segment is also included to indicate that the order message is in response to an **ORD** or **ORN** request message). Each group of OBR segments defines the orders for that particular patient identified by the preceding P segment. For **ORD** requests, previously entered orders will be returned; if no orders are available for the specified patient or test or if the specified patient is not known to the system, only one OBR segment is transmitted in response, having zero requestor and producer accession numbers, an action code of **G**, and an order result status code of **Y** or **Z**. The **ORD** request has a single optional qualifier, which may be the producer (filler) accession number of a particular order, or which may be the keyword **LAST** (used to request the latest order on file), **NEXT** (used to request the oldest scheduled or pending order on file or the next order in sequence), or **ALL** (the default, used to request all scheduled or pending orders on file). For **ORN** requests, a newly generated order will be returned, containing a unique producer accession number and an action code of **G** (generated order); no qualifiers may be used.

9.5.15 The following are examples of order request messages and the corresponding responses and acknowledgments. In these examples, **<CR>** indicates a carriage return character.

9.5.15.1 Example of an **ORD** request:

Query (requests next scheduled order on patient with ID 4567890):

```
H|^~\&|22626||EEGA1|||||EEGS1||P|E.3|19920723122514<CR>
Q|1|4567890|4567890|ALL|||||||ORD^NEXT<CR>
L|1||0|3|22626<CR>
```

Response (returns next scheduled order on patient 4567890):

```
H|^~\&|53286||EEGS1|||||EEGA1||P|E.3|19920723122542<CR>
MSA|AA|22626<CR>
P|1|4567890|4567890||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording||19920722095216|||||N|<CR>
A|^dementia|^62 year old male with 3 month hx of myoclonus, cognitive decline, <CR>
A|and memory loss|||32975^Smith&John&P&III&Dr&MD|444-3555|||||||EN|<CR>
A|S|||||WHLC||||||19920723120000<CR>
L|1||1|8|53286<CR>
```

Acknowledgment (echoes OBR segment with status changed to **I**):

```
H|^~\&|22627||EEGA1|||||EEGS1||P|E.3|19920723122606<CR>
MSA|AA|53286<CR>
P|1|4567890|4567890||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording||19920722095216|<CR>
A|19920723122606||||N|^dementia|^62 year old male with 3 month hx of <CR>
A|myoclonus, cognitive decline, and memory loss|||32975^Smith&John&P&III&Dr&<CR>
A|MD|444-3555|||||||EN|I|||||WHLC||||^Sullivan&Joyce&D&&Ms<CR>
L|1||1|8|22627<CR>
```

9.5.15.2 Example of an **ORN** request:

Query (requests generation of new order for patient 4321098, test 95930):

```
H|^~\&|22628||EEGA1 (EEG data acquisition)|||||EEGS1 (EEG storage system)|<CR>
A||P|E.3|19920723132647<CR>
Q|1|4321098&8&M10|4321098&8&M10|95930^Visual evoked potential study||||||<CR>
A||ORN<CR>
L|1||0|5|22628<CR>
```

Response (returns generated order for patient 4321098, test 95930):

```
H|^~\&|53287||EEGS1 (EEG storage system)|||||EEGA1 (EEG data acquisition)|<CR>
A||P|E.3|19920723132658<CR>
MSA|AA|22628<CR>
P|1|4321098&8&M10|4321098&8&M10<CR>
OBR|1|1235^EEGS1|1235^EEGS1|95930^Visual evoked potential study||<CR>
A|19920723132658|||||G|||||||||||||EN|O<CR>
L|1||1|7|53287<CR>
```

Acknowledgment (echoes P and OBR segments with additional information):

```
H|^~\&|22629||EEGA1 (EEG data acquisition)|||||EEGS1 (EEG storage system)|<CR>
A||P|E.3|19920723132715<CR>
MSA|AA|53287<CR>
P|1|4321098&8&M10|4321098&8&M10||Harvey^Jane^J^^Mrs||19600123|F<CR>
OBR|1|1235^EEGS1|1235^EEGS1|95930^Visual evoked potential study||<CR>
A|19920723132658|19920723132715||||G||^32 year old female with 2 week hx <CR>
A|of blurred vision in right eye. Rule out multiple sclerosis.|||||||||||<CR>
A|EN|I|||||||||^Quinlan&Daniel&S&&Mr<CR>
L|1||1|9|22629<CR>
```

9.5.16 *Requests for Equipment Settings*—These requests are used to obtain data from a machine that is used for waveform data acquisition, storage, or display concerning the stored montages or stimulator programs on that machine. For example, this may be used by a *lower level* machine (such as an intelligent amplifier) to request settings to be used for waveform data processing from a *higher level* machine (such as an EEG data acquisition unit), or by a *higher level* machine to obtain the current settings in use by a *lower level* machine. The **MTG** request asks for stored montage, channel, and electrode data, while the **STM** request asks for stored stimulator program data. The **MTG** request also may be used to obtain a list of available montages or a specific montage's channel and electrode definitions from a system that contains a database of stored montages for general use (not related to a specific study in progress). Only systems that are concerned with waveform data need implement these requests, and only those requests needed for the particular application need be implemented. These requests may be used either to obtain the current equipment settings in use for a particular specified study that is in progress (useful for machines which may be involved simultaneously in more than one study on more than one patient at a time), or they may be used to obtain the current equipment settings on the target machine regardless of whether or not a study is in progress (for example, when querying settings of an intelligent amplifier). The patient ID fields of the Q segment identify a particular patient for whom data are desired; alternatively, the keyword **ALL** (which is the default if not specified) may be used when a particular patient need not be identified (for example, when the target machine does not allow more than one simultaneous study, or when it is desired to retrieve stored montages for general use, instead of for a particular patient). Also, the test/ observation ID field of the Q segment contains the identifier of the test for which data are desired; alternatively, the keyword **ALL** (which is the default if not present) may be used when a particular study or test need not be identified (for example, when a **MTG** request is used to retrieve montages for general use for all supported studies, instead of for a particular study).

9.5.16.1 For the **MTG** request, two qualifiers may optionally be used. The first qualifier specifies a particular montage number (as used in a MTG category result segment) whose data are desired; for retrieving electrode definitions, a zero value may be used to specify the common electrode set (those defined by ELC category result segments transmitted prior to the first MTG category result segment). If omitted, data for all montages are returned. The second qualifier specifies the type and level of detail of montage data which is desired. This qualifier is a keyword (data type ID) which may be one of the values listed in Table 9-10. The **NAM** code indicates that only MTG category result segments are returned. The **ELC** code indicates that MTG and ELC category result segments are returned (first the ELC segments defining the common electrode set, if any, then a series of MTG segments each followed by a set of ELC segments); however, if montage zero is specified in the second qualifier, only the common ELC category result segments are returned. The **CHN** code indicates that MTG and CHN category result segments are returned. The **SEL** qualifier indicates that MTG and SEL category result segments are returned (with the MTG category result segments specifying the montage names and number of channels, and the SEL category result segments specifying the functions assigned to particular montages in the queried system). If the queried system does not implement auxiliary montage selections, the **SEL** qualifier has the same result as the **NAM** qualifier. The **ALL** qualifier indicates that MTG, ELC, CHN, and (if implemented) SEL category result segments are returned.

9.5.16.2 For the **STM** request, no qualifiers may be used. The **STM** request causes STM and TIM category result segments to be returned. TIM category result segments define the time (relative to the start of the stimulation program) at which stimuli occur (or begin or end), while STM category result segments define the characteristics of the stimuli or trains of stimuli.

9.5.16.3 When a message containing a request for equipment settings is received by the destination system, it responds by sending a message back to the requesting system. The response message to a request for equipment settings addressed to a machine on which no study is currently in progress (including a request for stored montages for general use) will contain a dummy patient identifying segment specifying a zero patient ID field and a null patient name field (**""**), and a dummy order (OBR) segment specifying zero requestor and producer accession number fields and action code **G** (generated order) and an appropriate test/observation ID for the type of equipment settings requested (for example, 9581X using **AS4** codes for generic EEG study stimulator programs, or 95900 using **AS4** codes for motor NCS montages). In response to a request for stored montages for general use that specifies **ALL** for the test/observation ID, multiple dummy OBR segments and associated OBX segments may be returned (one for each test type for which there are stored montages). However, the response message to a request for equipment settings which apply to a particular patient and study will contain appropriate patient identifying and order (OBR) segments. The format of a NCCLS LIS 5-A query response message is as follows:

```
H       Message header segment
MSA     Message acknowledgment segment
P       Patient identifying segment (identifies patient being tested, if any)
OBR     Order segment (identifies the order for the test in progress, if any)
OBX     Result segment 1 (MTG/CHN/ELC/SEL category for MTG,TIM/STM category for STM, optional ERR
           category)
OBX     Result segment 2
...     (Possible additional OBR/OBX segments groups)   ...
L       Message terminator segment
```

9.5.17 The following are examples of query messages and the corresponding responses. In these examples, **<CR>** indicates a carriage return character.

9.5.17.1 Example of a montage query:

Query (requests names of all stored EEG montages for general use):

```
H|^~\&|22788||EEGA1 (EEG data acquisition)|||||EEGS1 (EEG storage system)|<CR>
A||P|E.3|19920723132647<CR>
Q|1|ALL|ALL|9581X^EEG studies|||||||MTG^^NAM<CR>
L|1||0|4|22788<CR>
```

Response (returns names of all stored EEG montages for general use):

```
H|^~\&|53423||EEGS1 (EEG storage system)|||||EEGA1 (EEG data acquisition)|<CR>
A||P|E.3|19920723132658<CR>
```

```
MSA|AA|22788<CR>
P|1|0|0||""<CR>
OBR|1|0|0|9581X^EEG studies|||||||G|||||||||||||F<CR>
OBX|1|CM|9581X&MTG^EEG studies|1|1&LR-21.1 (A1/2)^21<CR>
OBX|2|CM|9581X&MTG^EEG studies|2|2&LB-21.1^21<CR>
OBX|3|CM|9581X&MTG^EEG studies|3|3&TB-21.1^21<CR>
OBX|4|CM|9581X&MTG^EEG studies|4|4&LR-16.1 (A1/2)^16<CR>
OBX|5|CM|9581X&MTG^EEG studies|5|5&LB-16.1^16<CR>
OBX|6|CM|9581X&MTG^EEG studies|6|6&TB-16.1^16<CR>
L|1||1|12|53423<CR>
```

9.5.17.2 Another example of a montage query:

Query (requests channels in montage 1 for patient 4567890):

```
H|^~\&|22789||EEGA1|||||EEGS1||P|E.3|19920723122514<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816^EEG recording|||||||MTG^1^CHN<CR>
L|1||0|3|22789<CR>
```

Response (returns montage 1 channels for patient 4567890, order 1234):

```
H|^~\&|53424||EEGS1|||||EEGA1||P|E.3|19920723122542<CR>
MSA|AA|22789<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording||19920723095216|<CR>
A|19920723122506||||N|^dementia|^62 year old male with 3 month hx of <CR>
A|myoclonus, cognitive decline, and memory loss|||32975^Smith&John&P&III&Dr&<CR>
A|MD|444-3555|||||||EN|I|||||WHLC||||^Sullivan&Joyce&D&&Ms<CR>
OBX|1|CM|95816&MTG^EEG recording|1|1&LR-21.1 (A1/2)^21<CR>
OBX|2|CM|95816&CHN^EEG recording|1|1^Fp1&Av^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&70&6~2^Fp2&Av^^1.015&0~3^F3&Av^^0.983&0~4^F4&Av^^<CR>
A|1.005&0~5^C3&Av^^0.964&1~6^C4&Av^^0.993&0~7^P3^Av^^0.989&0~8^P4&Av^^<CR>
A|1.013&0~9^O1&Av^^1.106&0~10^O2&Av^^0.992&2~11^F7&Av^^<CR>
A|0.987&0~12^F8&Av^^1.002&0~13^T3&Av^^1.076&-1~14^T4&Av^^<CR>
A|1.112&0~15^T5&Av^^0.988&0~16^T6&Av^^1.087&0~17^Fpz&Av^^<CR>
A|0.992&0~18^Fz^Av^^1.135&0~19^Cz&Av^^0.988&0~20^Pz&Av^^<CR>
A|1.103&0~21^Oz&Av^^0.998&0<CR>
L|1||1|17|53424<CR>
```

9.5.17.3 Example of a stimulus program query; the stimulus program specifies flash visual stimulation to both eyes at rates 3 Hz from 0 to 10 s, 10 Hz from 15 to 25 s, and 20 Hz from 30 to 40 s after the start of the program:

Query (requests current stimulus program for patient with ID 4567890):

```
H|^~\&|53425||EEGS1|||||EEGA1||P|E.3|19920723122514<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816^EEG recording|||||||STM<CR>
L|1||0|3|53425<CR>
```

Response (returns stimulus program for patient 4567890, order 1234):

```
H|^~\&|22790||EEGA1|||||EEGS1||P|E.3|19920723122542<CR>
MSA|AA|53425<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording||19920723095216|<CR>
A|19920723122506||||N|^dementia|^62 year old male with 3 month hx of <CR>
A|myoclonus, cognitive decline, and memory loss|||32975^Smith&John&P&III&Dr&<CR>
A|MD|444-3555|||||||EN|I|||||WHLC||||^Sullivan&Joyce&D&&Ms<CR>
OBX|1|CM|95816.31&TIM^EEG recording, during photic stimulation|1|<CR>
A|00000000000000.000<CR>
OBX|2|CM|95816.31&STM^EEG recording, during photic stimulation|1|<CR>
A|BEGIN^FLS^T-XX000-BIL&bilateral eye^3^0.00001^22^cd.s/m2^WHT<CR>
```

```
OBX|3|CM|95816.31&TIM^EEG recording, during photic stimulation|2|<CR>
A|00000000000010.000<CR>
OBX|4|CM|95816.31&STM^EEG recording, during photic stimulation|2|<CR>
A|END^FLS^T-XX000-BIL&bilateral eye^3^0.00001^22^cd.s/m2^WHT<CR>
OBX|5|CM|95816.31&TIM^EEG recording, during photic stimulation|3|<CR>
A|00000000000015.000<CR>
OBX|6|CM|95816.31&STM^EEG recording, during photic stimulation|3|<CR>
A|BEGIN^FLS^T-XX000-BIL&bilateral eye^10^0.00001^22^cd.s/m2^WHT<CR>
OBX|7|CM|95816.31&TIM^EEG recording, during photic stimulation|4|<CR>
A|00000000000025.000<CR>
OBX|8|CM|95816.31&STM^EEG recording, during photic stimulation|4|<CR>
A|END^FLS^T-XX000-BIL&bilateral eye^10^0.00001^22^cd.s/m2^WHT<CR>
OBX|9|CM|95816.31&TIM^EEG recording, during photic stimulation|5|<CR>
A|00000000000030.000<CR>
OBX|10|CM|95816.31&STM^EEG recording, during photic stimulation|5|<CR>
A|BEGIN^FLS^T-XX000-BIL&bilateral eye^20^0.00001^22^cd.s/m2^WHT<CR>
OBX|11|CM|95816.31&TIM^EEG recording, during photic stimulation|6|<CR>
A|00000000000040.000<CR>
OBX|12|CM|95816.31&STM^EEG recording, during photic stimulation|6|<CR>
A|END^FLS^T-XX000-BIL&bilateral eye^20^0.00001^22^cd.s/m2^WHT<CR>
L|1||1|32|22790<CR>
```

9.5.18 *Requests for Results*—These requests are used to obtain results of a completed study (waveform or report data, or both) from another system, or to obtain status information about an incomplete or in-progress order. These include **RES, REP**, and **RBL** requests. All of these requests lead to a response message sent over the same communication channel as that used to make the request; this differs from the real-time data transmit and receive requests described in 9.5.20, which usually use a separate communication channel. The **CAN** request allows a result transmission initiated by a **RES**, **REP**, or **RBL** request to be canceled while in progress.

9.5.18.1 The **RES** request (which is the default subject filter code when none is specified in a query) will return all available result data for a completed study, or will return only the status of an incomplete or in-progress order. The **REP** request is similar, but returns only reports, not waveform data and annotations (that is, the kind of data which is handled by a hospital or clinic result inquiry system and which has meaning to the original ordering physician, as opposed to data which is required for interpretation of the study). Generally, report data includes the information categories described in Section 8, although other categories may be included in some implementations (such as CNP). A single **RES** or **REP** request may ask for all or some of the results for a given test or multiple tests, specified as a list. Alternatively, it may request results for all tests performed on a single date or a series or range of dates, and for an individual patient, groups of patients, or all patients. However, this Technical Standard does not require all systems to be able to respond to all types of queries (by date, by date range, by patient, by patient group, etc.) or to maintain data on file for multiple tests and multiple patients. The most complete query functions would generally be implemented on one or more systems designed to support result inquiry, while other systems may only implement rudimentary result inquiry functions, if any. In these requests, the patient ID fields of the Q segment identify the particular patient or patients (specified as a list, separated by repeat delimiters) whose data are desired; the keyword **ALL** indicates that data for all patients on file are desired. Also, the test/observation ID field of the Q segment contains the identifier of the test or tests (specified as a list, separated by repeat delimiters) for which data are desired; the keyword **ALL** indicates that data for all tests performed on the patient(s) are desired. The beginning request results and ending request results date/time fields of the Q segment may be used to limit the results returned to those studies performed (field 6 = **S**) or reported (field 6 = **R**) within the specified time range, for requests which use the keyword **ALL** in the patient ID or test/observation ID fields.

9.5.18.2 The **RBL** request asks for a block of waveform data and related annotations occurring within a time window (epoch) defined by a starting and an ending time, specified in the beginning request results and ending request results date/time fields of the Q segment, which are both required fields for this request. This request should specify a single patient ID and a single test/observation ID, not a list or the keyword **ALL**. It may be used, for example, by waveform data review systems that need to obtain a single screen or page worth of waveform data at one time for display purposes. The data returned normally includes the montage, electrode, and channel definitions in effect at the beginning of the epoch or time window (MTG, ELC, and CHN category result segments), plus any changes to these definitions that occurred during the epoch. The data also includes a TIM category result segment that defines the start and duration of the requested epoch, the sampling interval of the waveform data for the epoch, the data format, and averaging parameters (if the data was averaged, for example, for evoked potentials) followed by one or more WAV category result segments. If the specified time window spans more than one epoch of waveform data (more than one block of data not contiguous in time) or if the sampling interval, data format, or averaging parameters change during the time window, the queried system should respond by transmitting multiple epochs of data, each preceded by a TIM category result segment, until data for the entire requested time window had been transmitted. In addition, the data may include annotation result segments such as STM or ANA category result segments that apply to the specified epoch (time window). Thus, the data returned by the **RBL** request can serve as a self-contained definition of the specified epoch of data. For efficiency reasons, not all of this data may be transmitted in practice. For example, a waveform data review system may be *paging* through a long EEG or PSG recording, one screen or page at a time, and it would be inefficient to return all montage, electrode, and channel definitions each time a new screen or page of data is transmitted, since these can be retained by the review system. In this circumstance, the mechanism described in 4.7.4 of including information category codes following the test/observation ID in the Q segment can be used to limit the data returned to certain categories, such as TIM, WAV, ANA, and STM. However, the transmitting system in this case would probably still send MTG, CHN, or ELC category result segments if the montage, channel, or electrode definitions changed in the requested epoch compared to the last epoch transmitted.

9.5.18.3 The **RES, REP**, and **RBL** requests have two optional qualifiers. The first qualifier specifies the producer accession number of the test whose results are desired; it is used to uniquely identify a particular test (order); when omitted, results for all tests of the specified type on the specified patient will be returned. When it is specified, the request should specify a single patient ID and a single test/observation ID, not a list or the keyword **ALL**. The second qualifier specifies the particular result (OBX) segment sequence number (field 2 of the OBX segment) with which result transmission is to commence. This qualifier is only used when an error occurred during result transmission (or when transmission was canceled by a **CAN** request) and it is necessary to restart transmission from a particular result segment rather than restarting from the beginning (OBX segment number 1). Not all implementations are able to restart transmission exactly from the specified OBX segment sequence number; if necessary, the system receiving the result request can begin retransmission at an OBX segment prior to the requested segment, and the requestor can ignore any OBX segments that it has already received. When an OBX segment sequence number is specified, the producer accession number of the specific test desired should also be specified in the first qualifier to ensure that the correct set of results are returned in the case of multiple tests on file for a given patient. The message containing the requested results will contain the OBR segment for the order (acting as a result header), followed by OBX segments beginning at or before the requested segment, with their original segment numbers retained (rather than renumbering them from 1).

9.5.18.4 While transmission of lengthy results initiated by a **RES, REP**, or **RBL** request is in progress, a **CAN** request may be transmitted to abort the result transmission immediately or to cancel transmission of some requested results that have not yet been transmitted. The **CAN** request does not affect real-time waveform data transmission initiated by a **BEG** request (see 9.5.20). If a result data transmission is aborted, it can only be restarted by retransmitting a **RES, REP**, or **RBL** request. For the **CAN** request, the patient ID fields of the Q segment identify the particular patient or patients, the test/observation ID field of the Q segment contains the identifier of the test or tests, and the beginning request results and ending request results date/time fields of the Q segment specify the time range of the results whose transmission is to be canceled; these fields may be identical to those in the original **RES**, **REP**, or **RBL** request which requested the result transmission (causing transmission of all of the originally requested results to be aborted immediately), or they may specify a subset of the originally requested results; in the latter case, those results requested to be canceled will be eliminated from the result transmission if they have not yet been transmitted, but the in-progress transmission of other requested results will continue. The **CAN** request has a single optional qualifier, which is the producer accession number of the test whose result transmission should be canceled; it is used to uniquely identify the particular test (order) of the specified type on the specified patient whose result transmission should be canceled. When omitted, transmission of results for all tests of the specified type on the specified patient are canceled. When it is specified, the **CAN** request should specify a single patient ID and a single test/observation ID, not a list or the keyword **ALL**.

9.5.18.5 When a message containing a request for results (**RES, REP**, or **RBL**) is received by the destination system, it responds by sending a message back to the requesting system. The format of a NCCLS LIS 5-A query response message is as follows:

```
H          Message header segment
MSA        Message acknowledgment segment
P          First patient identifying segment
OBR        First order segment for first patient
OBX        Result segment 1
OBX        Result segment 2
⋮
OBR        Second order segment for first patient
OBX        Result segment 1
OBX        Result segment 2
⋮          (more order and result segments)
P          Second patient identifying segment
⋮          (all of the structure repeats)
L          Message terminator segment
```

9.5.19 The following are examples of request result messages and the corresponding responses. In these examples, **<CR>** indicates a carriage return character.

9.5.19.1 Example of a request for results of all studies on all patients performed on March 24, 1990 between 08:00 and 09:45; the response to this query could be the example message given in Appendix C , with the (optional) message type and trigger event code in the message header changed from **ORU^R01** to **ORF^R02** and an MSA (message acknowledgment) segment added after the H segment:

```
H|^~\&|62784|34X96ABE59YW|Neuro (Sunnyville Neurologic Clinic)|<CR>
A|102 W Main Street^Mail Stop 22A^Sunnyville^IN^66666||(555)444-2222|<CR>
A||NEULAB (Sunnyville Neurophysiology Lab)|Example|P|E.3|19900324101205<CR>
Q|1|ALL|ALL|ALL|S|199003240800|199003240945|32975^Smith&John&P&III&Dr&MD<CR>
A||444-3555<CR>
L|1||0|6|62784<CR>
```

9.5.19.2 Example of a request for a block of waveform data for an EEG study from time 08:25:40 to time 08:25:50 on March 24, 1990:

Query (requests waveform data block for patient 4567890):

```
H|^~\&|46372||EEGR1|||||EEGS1||P|E.3|19900324100134<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816||19900324082540|19900324082550||||RBL<CR>
L|1||0|3|46372<CR>
```

Response (returns waveform data and annotations in specified time range):

```
H|^~\&|53424||EEGS1|||||EEGR1||P|E.3|19900324100135<CR>
MSA|AA|46372<CR>
P|1|4567890&1&M10|4567890&1&M10<CR>
OBR|1|5678^Neuro|1234^EEG|95816|||19900324081216||||N|||||||||||||R<CR>
OBX|1|CM|95816&MTG|1|1&LR-21.1 (A1/2)^21<CR>
OBX|2|CM|95816&ELC|1|1&Fp1^T-Y0100&head^DP&Au&0.6^90&TH^<CR>
A|108&PH~2&Fp2^^^90&TH^72&PH~3&F3^^^64&TH^129.1&PH~4&F4^^^64&TH^<CR>
A|50.9&PH~5&C3^^^45&TH^180&PH~6&C4^^^45&TH^0&PH~7&P3^^^64&TH^<CR>
A|230.9&PH~8&P4^^^64&TH^309.1&PH~9&O1^^^90&TH^252&PH~10&O2^^^<CR>
A|90&TH^288&PH~11&F7^^^90&TH^144&PH~12&F8^^^90&TH^36&PH~<CR>
A|13&T3^^^90&TH^180&PH~14&T4^^^90&TH^0&PH~15&T5^^^90&TH^216&PH~<CR>
A|16&T6^^^90&TH^324&PH~17&Fpz^^^90&TH^90&PH~18&Fz^^^45&TH^<CR>
A|90&PH~19&Cz^^^0&TH^0&PH~20&Pz^^^45&TH^270&PH~21&Oz^^^90&TH^<CR>
A|270&PH~22&A1^^^120&TH^180&PH~23&A2^^^120&TH^0&PH~24&Av^^DERIV^<CR>
A|0.5&A1^0.5&A2<CR>
```

```
OBX|3|CM|95816&CHN|1|1^Fp1&Av^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&70&6~2^Fp2&Av^^1.015&0~3^F3&Av^^0.983&0~4^F4&Av^^<CR>
A|1.005&0~5^C3&Av^^0.964&1~6^C4&Av^^0.993&0~7^P3^Av^^0.989&0~8^P4&Av^^<CR>
A|1.013&0~9^O1&Av^^1.106&0~10^O2&Av^^0.992&2~11^F7&Av^^<CR>
A|0.987&0~12^F8&Av^^1.002&0~13^T3&Av^^1.076&-1~14^T4&Av^^<CR>
A|1.112&0~15^T5&Av^^0.988&0~16^T6&Av^^1.087&0~17^Fpz&Av^^<CR>
A|0.992&0~18^Fz^Av^^1.135&0~19^Cz&Av^^0.988&0~20^Pz&Av^^<CR>
A|1.103&0~21^Oz&Av^^0.998&0<CR>
OBX|4|CM|95816.2101&TIM|1|19900324082540.000^0.005^10.000^DNC<CR>
OBX|5|CM|95816.2101&WAV|1|298^12^-13^-263^-1023^-335^-78^432^1024^886^<CR>
⋮    (more WAV and ANA category result segments for 10-s epoch)
L|1||1|2315|53424<CR>
```

9.5.19.3 Example of a request for reports only for a VEP study:

Query (requests reports for VEP study 1235 for patient with ID 4321098):

```
H|^~\&|62785||Neuro|||||NEULAB||P|E.3|19900325091543<CR>
Q|1|4321098&8&M10|4321098&8&M10|95930^Visual evoked potential study||||||<CR>
A|REP^1235<CR>
L|1||0|4|62785<CR>
```

Response (returns VEP study reports for patient 4321098, order 1235):

```
H|^~\&|22791||NEULAB|||||Neuro||P|E.3|19900325091612<CR>
MSA|AA|62785<CR>
P|1|4321098&8&M10|4321098&8&M10||Harvey^Jane^J^^Mrs||19600123|F|W|214 First <CR>
A|Street^Apt. 315^Hometown^IN^66667||445-3333Cday~445-4444Cevening|53927^Jones&<CR>
A|Thomas&L&&Dr&MD|||142^cm|55^kg|||||Right||OP|Neuro|||M||||19900323<CR>
OBR|1|5683^Neuro|1235^EEG|95930^Visual evoked potential study||19900323132546|<CR>
A|19900324093532|19900324093858|||N||^30 year old female with 2 week hx of<CR>
A| blurred vision in right eye. Rule out multiple sclerosis.|||53927^Jones&<CR>
A|Thomas&L&&Dr&MD|444-3666|||||19900324101203||EN|F|||||||97235^Berger&Hans&&&Dr|<CR>
A|27593^Jones&Mary&S&&Dr&MD|^Quinlan&Daniel&S&&Mr|^Quincy&Susan&R&&Ms<CR>
OBX|1|NM|95930.0111000110^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 <CR>
A|stimulus rate||1.05|hz|1.05-1.05|N<CR>
OBX|2|NM|95930.0112000110^Visual evoked potential study, full field checkerboard <CR>
A|pattern reversal stimuli to right eye: sample number 1 <CR>
A|stimulus rate||1.05|hz|1.05-1.05|N<CR>
OBX|3|NM|95930.0111000170^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 <CR>
A|visual pattern element size||0.5|deg|0.5-0.5|N<CR>
OBX|4|NM|95930.0112000170^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 <CR>
A|visual pattern element size||0.5|deg|0.5-0.5|N<CR>
OBX|5|NM|95930.0111000180^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 <CR>
A|visual field size||15|deg|15-15|N<CR>
OBX|6|NM|95930.0112000180^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 <CR>
A|visual field size||15|deg|15-15|N<CR>
OBX|7|NM|95930.0111000121^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 N75 <CR>
A|peak latency||84.0|ms|55-96|N||A^S<CR>
⋮    (other null category OBX segments with results of study)
OBX|39|TX|95930.0&GDT^Visual evoked potential study|1|  The subject's <CR>
A|visual acuity was 20/20 OD and 20/20 OS with corrective lenses. Pupils <CR>
A|were symmetric, visual fields intact by confrontation testing, and <CR>
A|subject was able to fixate well.~~  Pattern reversal visual evoked <CR>
A|potentials were obtained using a stimulus rate of 2.1 Hz and a total <CR>
A|field size of 15 degrees using both standard 30' check size and large 60' <CR>
A|check size, for each eye separately, recording referentially from vertex, <CR>
A|occipital, and inion electrodes (left ear reference), and recording from <CR>
A|a bipolar vertex-occipital derivation. 100 epochs were averaged. The <CR>
```

```
A|N75, P100, and N145 peaks were well formed and had normal latencies and <CR>
A|morphologies at the occipital and inion sites.<CR>
OBX|40|TX|95930.0&MDT|1|  The pattern reversal visual evoked potentials are <CR>
A|normal bilaterally. This does not exclude the possibility of <CR>
A|demyelinating disease.<CR>
OBX|41|CE|95930.0&ANT|1|3^Bilaterally^AS4&DIST<CR>
OBX|42|CE|95930.0&IMP|1|1^Normal^AS4&VEPD|||N<CR>
L|1||1|135|22791<CR>
```

9.5.19.4 Example of a request to cancel a previous request (example 1) for results of all studies on all patients performed on March 24, 1990 between 08:00 and 09:45:

```
H|^~\&|62785|34X96ABE59YW|Neuro (Sunnyville Neurologic Clinic)|<CR>
A|102 W Main Street^Mail Stop 22A^Sunnyville^IN^66666||(555)444-2222|<CR>
A||NEULAB (Sunnyville Neurophysiology Lab)|Example|P|E.3|19900324101222<CR>
Q|1|ALL|ALL|ALL|S|199003240800|199003240945|32975^Smith&John&P&III&Dr&MD<CR>
A||444-3555||CAN<CR>
L|1||0|6|62785<CR>
```

9.5.20 *Remote Control and Status Requests*— These requests are used to begin (**BEG**), pause (**PAU**), resume (**RSM**), or terminate (**END**) a function on a remote system, and to obtain the current status (**STA**) of a function on a remote system. Current status is returned with all of these requests, as an indication of success or failure of the remote control operation. The **BEG** request is used to initiate on the remote machine a particular available function which is not currently active. The **PAU** request is used to temporarily suspend an active function on the remote machine. The **RSM** request is used to resume a temporarily suspended active function or to request retransmission of real-time data. The **END** request is used to terminate an active function, closing associated data files or communication channels. If an active function encounters an error condition (such as storage device full), the remote system may suspend that function; an **STA** request could then be used to determine that the function had encountered an error and find out the nature of the error, after which a **RSM** request could resume the function (if the error is recoverable), or an **END** request could terminate it.

9.5.20.1 The functions that can potentially be controlled on a remote machine are listed in Table 9-5 (system function identifiers); other function identifiers may be used which have meaning to the sending and receiving system. However, a given system generally will perform only a few of these functions, and only a subset of the functions it performs will be available for remote control. For example, functions such as report generation are generally initiated locally and cannot be remotely controlled. Functions that are commonly implemented on networked systems designed for waveform acquisition or waveform storage are the real-time waveform data transmission (**WTM**) or reception (**WRC**) functions. The **WTM** function usually means that the remote machine transmits waveform data as acquired or processed in real time to the requesting system. The **WRC** function usually means that the remote machine receives waveform data as it becomes available in real time from the requesting system. However, these functions may also be used to transmit or receive previously acquired and stored waveform data at rates exceeding the acquisition rate (faster than *real time*) using a communication channel other than the primary communication channel. The rate of transmission is determined by the transmitting system and the communication channel, and it is assumed that the receiving system can process, display, or store the data as fast as it is sent (although the receiver can **PAU**se and **R**e**S**u**M**e the data transmission function on the remote system, if necessary, using remote control requests sent over the primary communication channel). An implementation may allow remote control of the **WTM** function, but only local control of the **WRC** function. Initiating real-time transmission of waveform data from machine **B** to machine **A** is then done under the control of machine **A**, which sends a **BEG**in **WTM** request to machine **B** and also initiates a **WRC** function locally. The opposite can also be implemented (when the intended receiver is the remote machine). If it is necessary to begin, end, pause, or resume several functions on a remote machine simultaneously, multiple requests (multiple Q segments) may be transmitted in a single message. For example, it is possible to **BEG**in a **WRC** function and a **WPR** function on a remote machine, then start sending data in real-time for remote printing. Transfer of a data file from a remote archival system to a local machine could similarly be done by **BEG**inning a **WRE** function and a **WTM** function on the remote machine, then storing the data received on a local device.

9.5.20.2 The remote control and status requests must specify a particular patient and study to which the request applies. The patient ID fields of the Q segment identify a single patient, and the test/observation ID field of the Q segment contains an identifier of the single test or study affected. The beginning request results and ending request results date/time fields of the Q segment are not used for these requests. These requests always affect an in-progress or completed (as opposed to scheduled but not yet begun) study of the specified type on the specified patient; if no study is currently in progress or no waveform data or reports are available, an error status is returned.

9.5.20.3 These requests may use one or more qualifiers. The first qualifier specifies the system function identifier. This qualifier is required for **BEG**, **PAU**, **RSM**, and **END** requests, but is optional for **STA** requests; if not specified, the status of all available functions on the remote system (related to the specified patient and study) are returned. The second and third optional qualifiers are applicable for **BEG** requests that initiate certain functions. For the **WDI, WPR, RDI**, and **RPR** functions, the second qualifier specifies the printer/display device for waveform data or reports. For the **WST, WAR, WRE**, **RST, RAR**, and **RRE** functions, the second qualifier specifies the storage device for waveform data or reports, and the third qualifier specifies the file identifier. For the **WTM** and **WRC** functions, the second qualifier specifies the communication channel on which waveform data should be transmitted or received. If the device or file ID or the communication channel are omitted, the remote system supplies appropriate values which may be determined from the other information in the request (such as the patient ID and test/observation ID). The supplied values are then returned as status information as described in 9.5.20.7. The requesting system may first query the remote system using the **SDV, SPD**, or **SCM** queries to obtain the identifiers of available storage devices, display devices, or communication channels on the remote system prior to transmitting the **BEG** request. The fourth and subsequent optional qualifiers in the **BEG** request may be used to pass additional data to the remote system concerning the function to be initiated; the use of these qualifiers is not defined by this Technical Standard, and is therefore considered to be nonstandard and non-portable.

9.5.20.4 The second optional qualifier is also applicable to **RSM** requests which specify the **WTM** function. For this function, the second qualifier specifies the particular result (OBX) segment sequence number with which real-time waveform data transmission is to be resumed. This qualifier is only used when an error occurred during real-time data transmission and it is necessary to resume transmission from a particular previously transmitted result segment rather than resuming after the segment at which transmission had been suspended. If WAV category result segments are among those retransmitted, it is the responsibility of the receiving system to keep track of the appropriate time, sampling interval, and transmitted data format applicable to these segments (or else, to request that transmission be restarted with the TIM category result segment at the start of an epoch). Not all implementations are able to restart transmission exactly from the specified OBX segment sequence number; if necessary, the transmitting system can begin retransmission at an OBX segment prior to the requested segment, and the receiver can ignore any OBX segments which it has already received. A **RSM** request specifying an OBX segment sequence number can be transmitted even if a previous **PAU** request had not been performed; in this case, the transmitter first suspends the current transmission, and then immediately resumes transmission at or before the specified OBX segment sequence number. The resulting data transmission will contain a sudden backward *jump* in OBX segment sequence numbers which can be detected and appropriately handled by the receiver. The **RSM** request cannot specify an OBX segment sequence number larger than that of the last transmitted result segment.

9.5.20.5 When a message containing a **STA, BEG, PAU, RSM**, or **END** request is received by the destination system, it responds by sending a message back to the requesting system. This message acknowledges the request and indicates whether the request was performed, what the current status of the referenced remote function is, and what errors occurred during processing of the request, if any. Separate response messages are sent for each request, even if more than one request is transmitted in a single message. The format of a NCCLS LIS 5-A response message is as follows:

```
H          Message header segment
MSA        Message acknowledgment segment
P          Patient identifying segment
OBR        Order segment (identifies the original order and returns status data)
```

```
OBX       Result segment (optional; ERR category with error code and message)
OBX       Result segment (STA category with active function status data)
L         Message terminator segment
```

9.5.20.6 If an error occurred in processing the request or an error was encountered previously by the function specified in the request, an ERR category result (OBX) segment may be transmitted following the OBR segment which contains an implementation-dependent error code (first component) and optional error message (second component), which may specify the cause or nature of the error (see 9.3.12). The occurrence of an error may also be flagged by the use of one of the order result status codes in the OBR segment (**Z** for unknown patient; **Y** for unknown order; or **X** for request cannot be performed). For example, if a **BEG** request is sent to a remote system specifying the **WAC** function, and the remote system is not capable of performing this function, a status code of **X** is returned in the OBR segment, and a following ERR category OBX segment could contain the error code 952 and the error message *waveform data acquisition not available on this system*. Or, if an error occurred in waveform real-time data transmission, a **STA** request specifying the **WTM** function could return a message containing an ERR category OBX segment with an error code of 997 and an error message, *real-time waveform data transmission paused due to network failure; system error code X23B*.

9.5.20.7 The OBR segment in the response message is followed by an STA category OBX segment containing status information. The observation value field of this category of result segment contains one or more subfields separated by repeat delimiters (~). Each subfield defines one active function status response; however, more than one active function status response may be returned only for **STA** requests that do not specify a single system function identifier as the first qualifier; for **STA** and other requests which do specify a single function, only the status of that function is returned. Each subfield consists of two or more components separated by component delimiters (^). The format of the STA category result segment is summarized in Table 9-11. The first component is the system function identifier (given in Table 9-5) which specifies the function whose status is being returned. The second component is the current function status code (given in Table 9-12). The third and subsequent components contain additional data concerning the system function; they are supplied only for certain system functions. For the **WDI, WPR, RDI**, and **RPR** functions, the third component is the current printer/display device for waveform data or reports. For the **WST, WAR, WRE, RST, RAR**, and **RRE** functions, the third component is the current storage device for waveform data or reports, and the fourth component identifies the file being used to store waveform data or reports. For the **WTM** and **WRC** functions, the third component identifies the communication channel on which waveform data are being transmitted or received. Additional data may also be returned for some functions by some systems; the meaning of these additional data is implementation-dependent, and use of additional data is therefore considered nonstandard and non-portable. The device, file, and communication channel identifiers contained in the active function status field are system- and implementation-dependent data, as described in 9.5.8. Further information about a given device or communication channel may be obtained when needed by transmitting an **SDV, SPD**, or **SCM** query as described in 9.5.10.

9.5.20.8 Besides returning a response message over the usual communication channel for inter-system messages, a **BEG** request specifying the **WTM** function causes waveform data to be transmitted in real time from the remote system to the requesting system, generally using a separate communication channel. The waveform data are transmitted in the form of a NCCLS LIS 5-A message; however, the message header, patient identifying, and order segments are transmitted immediately, and subsequent WAV category, ANA category, and related result segments defining waveform data and annotations are transmitted as they become available in real time; when the transmission ends (for example, because of an **END** request), the final result segments are transmitted followed by a message terminator segment. If transmission is paused (for example, by a **PAU** request), transmission of result segments stops temporarily, and when transmission is resumed (for example, by a **RSM** request), transmission continues with the next result segment; no additional message terminator/header segments are sent. A similar procedure is used when a real time receive (**WRC**) request is initiated; after obtaining the acknowledgment message from the remote system, the requestor begins sending a message to the receiver, including result segments as they become available, and the message continues until no further data are available, at which time a message terminator segment is sent and the receiver terminates the receive function. Note that the transmitted WAV category result segments may contain the actual waveform data (CM data type) or a pointer to the waveform data on a storage medium (RP data type); in the latter case, the receiving system must perform an additional procedure to actually retrieve the waveform data from the storage device in real time. Depending on available lower-level communication protocol error detection capabilities, messages sent in real time may wish to periodically include E (error checking) segments.

9.5.20.9 If an error is detected by the transmitting system during real-time transmission, transmission may be temporarily suspended until a **RSM** request is received or the error is corrected, as appropriate. If an error is detected by the receiving system during real-time data transmission, a **PAU** request may be sent to the transmitter, if appropriate, to terminate transmission until the error condition is corrected. If the transmitter learns that some transmitted data were lost, it may repeat the transmission of some previously transmitted result segments, using a result status code of **C** (corrected) in the OBX segments retransmitted; the receiver will recognize this and respond by substituting the new result segments for the previously transmitted segments. If WAV category result segments are among those retransmitted, a corrected TIM category result segment must also be transmitted prior to the WAV category result segments to specify the time, sampling frequency, and data format at the start of the retransmitted waveform data. Furthermore, if the montage or channel/electrode definitions had changed in the period of time spanned by the retransmitted segments, the appropriate MTG, CHN, and ELC category result segments should be retransmitted to establish the correct settings for the retransmitted waveform data. If the receiver detects that data was lost or garbled, it may send a **RSM** request specifying a particular result segment sequence number in the second qualifier to ask the transmitter to retransmit result segments beginning at or before the specified sequence number. The **RSM** request need not be preceded by a **PAU** request in this case.

9.5.20.10 The format of a message used for real-time waveform data transmission is as follows:

```
H       Message header segment
MSA     Message acknowledgment segment (if receiver initiates transfer by means of BEG)
P       Patient identifying segment
OBR     Order segment (identifies the original order for the test)
OBX     Result segment 1
OBX     Result segment 2
⋮       (segments are transmitted in real-time as data becomes available;
⋮       the transmission may be suspended and resumed anywhere in the message)
L       Message terminator segment (sent when transmission is completed)
```

9.5.21 The following are examples of control and status request messages and the corresponding responses. In these examples, **<CR>** indicates a carriage return character.

9.5.21.1 Example of two **BEG** requests asking that a remote system prepare to receive real-time waveform data on communication channel **NET2**, and store it on an optical disk, device **DO2**; after receiving the expected response messages, the requesting system may start transmitting a message containing real-time waveform data itself or pointers to blocks of waveform data on a storage medium using communication channel **NET2** to the remote system:

Request (initiates real-time data reception and waveform storage):

```
H|^~\&|25642||EEGA1|||||EEGS1||P|E.3|19920723122732<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816^EEG recording|||||||<CR>
A|BEG^WRC^NET2<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816^EEG recording|||||||BEG^WST^DO2<CR>
L|1||0|5|25642<CR>
```

Response number 1 (returns status of function **WRC** for order 1234):

```
H|^~\&|53433||EEGS1|||||EEGA1||P|E.3|19920723122742<CR>
MSA|AA|25642<CR>
```

```
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||19920723122606||||N|||<CR>
A|||||||||||||I<CR>
OBX|1|CM|95816&STA^EEG recording|1|WRC^A^NET2<CR>
L|1||1|7|53433<CR>
```

Response number 2 (returns status of function **WST** for order 1234):

```
H|^~\&|53434||EEGS1|||||EEGA1||P|E.3|19920723122747<CR>
MSA|AA|25642<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||19920723122606||||N|||<CR>
A|||||||||||||I<CR>
OBX|1|CM|95816&STA^EEG recording|1|WST^A^DO2^FILE1234<CR>
L|1||1|7|53434<CR>
```

9.5.21.2 Example of a **STA** request asking for status of all system functions for a specific test in progress:

Query (requests status for EEG recording for patient 4567890):

```
H|^~\&|53436||EEGS1|||||EEGA1||P|E.3|19920723124211<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816^EEG recording|||||||STA<CR>
L|1||0|3|53436<CR>
```

Response (returns status of functions **WAC, WPR, WDE, WTM**, and **WST**):

```
H|^~\&|25645||EEGA1|||||EEGS1||P|E.3|19920723124218<CR>
MSA|AA|53436<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||19920723122606||||N|||<CR>
A|||||||||||||I<CR>
OBX|1|CM|95816&STA^EEG recording|1|WAC^A~WPR^A^LPT1~WDE^A~<CR>
A|WTM^A^NET2~WST^A^C^DAT1234<CR>
L|1||1|8|25645<CR>
```

9.5.21.3 Example of an **END** request asking that a remote system terminate waveform data acquisition (**WAC)**; implicitly, this request also terminates associated functions such as waveform detection (**WDE**), real-time waveform data transmission (**WTM**), and waveform data storage (**WST**):

Request (terminates waveform data acquisition for EEG recording):

```
H|^~\&|53449||EEGS1|||||EEGA1||P|E.3|19920723124853<CR>
Q|1|4567890&1&M10|4567890&1&M10|95816^EEG recording|||||||END^WAC<CR>
L|1||0|3|53449<CR>
```

Response (returns status of function **WAC**):

```
H|^~\&|25654||EEGA1|||||EEGS1||P|E.3|19920723124912<CR>
MSA|AA|53449<CR>
P|1|4567890&1&M10|4567890&1&M10||Doe^John^Q^Jr^Mr|Deere|19300202|M<CR>
OBR|1|5678^Neuro|1234^EEGS1|95816^EEG recording|||19920723122606||||N|||<CR>
A|||||||||||||I<CR>
OBX|1|CM|95816&STA^EEG recording|1|WAC^C<CR>
L|1||1|7|25654<CR>
```

9.6 *Error Reporting in Two-Way Communication*— This Technical Standard extends NCCLS LIS 5-A and HL7 capabilities by providing certain error reporting facilities. When a system receives a message containing an error, it responds with a new message that acknowledges the received message and indicates the nature of the error.

9.6.1 Errors may be reported in several types of segments in the acknowledgment message. Errors involving the processing of an order are reported in the OBR segment order result status code field (see 9.3.10) and, if necessary, in an ERR category result segment (see 9.3.12). Errors returned by a request or query that concerns an order or an ordered test are also reported in this manner (see 9.5.20.6, for example). Errors returned by other requests or queries (such as system status queries and master database search requests) or errors involving message or segment syntax violations (including syntax-only errors in OBR segments) are reported in the text message field of an MSA segment in the acknowledgment message. The same error report may also be explicitly requested by use of the **ERR** query facility (see 9.5.10.11).

9.6.2 The error report returned in the MSA segment text message field consists of the string **ERR**, followed by an error code (alphanumeric value) followed by a space and an optional error message. Certain error codes are defined by this Technical Standard; these are listed in Table 9-13. An implementation need not use any or all of these error codes; however, if a receiver does check for and report these errors, it should use the error codes listed in Table 9-13. In addition, implementation-specific error codes may be used which have meaning to both the sending and receiving system. Codes 000 to 499 are reserved (message and general segment format errors 000-099; P segment errors 100-199; OBR segment syntax errors 200-299; OBX segment syntax errors 300-399; other segment errors 400-499); therefore, implementation-specific codes must be in the range 500-999. In Table 9-13, text in square brackets indicates a variable field, for which the appropriate value is substituted when the error message is composed: [segID] indicates a segment identifier (field 1), [seq#] indicates a segment sequence number (field 2), [fld#] indicates a field number, [cmp#] indicates a component number, and [sub#] indicates a subcomponent number.

TABLE 9-1 Order Action Codes

Code	Meaning
A	Add the ordered test to an existing order for the same patient.
C	Cancel previously transmitted order for the test named.
G	Generated order: the study was initiated by the diagnostic service.
N	New order to be performed.
R	Revise order: change previously transmitted order or modify test in progress (see 9.4).
S	Schedule the test for a future time.

TABLE 9-2 Order Result Status Codes

NOTE—**Priority** (temporal order in which codes may replace one another) is: Z-Y-X-D-O-S-I-R-P-M-F-C

Code	Meaning
C	Test complete, new corrected reports replace previously transmitted final reports.
F	Test complete, all verified final reports available.
M	Test complete, some verified final reports available, others are still missing and will be available later.
P	Test complete, only preliminary reports available, additional or confirmatory reports may be expected.
R	Test complete, primary (waveform) data available, reports are still pending.
I	Test in progress but incomplete.
S	Test scheduled, has not yet begun.
O	Order received, test not yet scheduled.
D	Order deleted (canceled) by requestor.
X	Request cannot be performed.
Y	No order on record for this test.
Z	Patient not known to system.

TABLE 9-3 ERR Category Result Segment Format

Components of Result Field	Type	Max length
Error Code	ST	20
Text Error Message	ST	200

TABLE 9-4 Request Types, Subject Filter Codes, and Qualifiers

Subject Filter Code	Request Type	Qualifier 1	Qualifier 2	Qualifier 3
	System Status, Configuration, and Capability Queries			
STI	System time	...	...	...
SID	System ID	...	...	...
SAV	System availability	...	...	...
SFN	System functions	...	...	...
SCM	System communications	com.ID	...	...
SDV	System storage devices	dev.ID	...	...
SPD	System display devices	dev.ID	...	...
ERR	Last error code/message	...	...	...
DTY	Data types	...	...	...
DLM	Data limits	...	...	...
DFO	Data formats	...	...	...
DFR	Data sample frequencies	...	...	...
	Master Database Search Requests			
OMD	Test/observation master data	...	...	...
DEM	Patient demographics	...	...	...
	Requests for Orders			
ORD	Get orders	acc.num	...	...
ORN	Generate new order	...	...	...
	Requests for Equipment Settings			
MTG	Get montage	mtg.num	dat.typ	...
STM	Get stimulus program	...	...	...
	Requests for Results			
RES	All results	acc.num	seg.num	...
REP	Reports only	acc.num	seg.num	...
RBL	Waveform data block	acc.num	seg.num	...
CAN	Cancel result message	acc.num	...	...
	Remote Control and Status Requests			
STA	Remote function status	func.ID	...	...
BEG	Begin remote function	func.ID	d/c.ID	file.ID
PAU	Pause remote function	func.ID	...	...
RSM	Resume remote function	func.ID	seg.num	...
END	End remote function	func.ID	...	...

TABLE 9-5 System Function Identifiers

Identifier	Function
WAC	Waveform data acquisition
WDI	Waveform screen display
WPR	Waveform printing
WDE	Waveform feature detection (such as spike, seizure)
WAN	Waveform analysis (such as frequency spectra)
WTM	Waveform data real-time transmission (to another system)
WRC	Waveform data real-time reception (from another system)
WST	Waveform data storage (short-term)
WAR	Waveform data archival (long-term)
WRE	Waveform data retrieval (from storage or archive)
RGE	Report generation
RDI	Report screen display
RPR	Report printing
RST	Report storage (short-term)
RAR	Report archival (long-term)
RRE	Report retrieval (from storage or archive)
DEM[A]	Patient demographic data storage
ORD[A]	Electronic test ordering
ORN[A]	Order accession number assignment
OMD[A]	Test/observation master data storage
MTG[A]	Montage/channel/electrode definition storage

[A]This function may be listed in the response to a **SFN** (system functions) query, but may not be referenced in a **BEG, PAU, RSM, END**, or **STA** request.

TABLE 9-6 Network Protocol and Parity/Baud Rate Codes

Code	Protocol	Meaning (Owner)
TCP	TCP/IP	Transmission control protocol/Internet protocol)
DNET	DECnet	Digital Equipment Corporation network protocol
SNA	SNA	Systems Network Architecture (IBM)
OSI	OSI	Open Systems Interconnection (ISO)
X25	X.25	ANSI protocol for wide area networks
IPX	IPX/SPX	internetwork packet exchange/sequenced packet exchange (Novell)

Parity/Baud Rate Codes

Even Parity	Odd Parity	No Parity	Corresponding Baud Rate
E3	O3	N3	300
E12	O12	N12	1200
E24	O24	N24	2400
E48	O48	N48	4800
E96	O96	N96	9600
E192	O192	N192	19200
E384	O384	N384	38400
E576	O576	N576	57600
E768	O768	N768	76800
E1152	O1152	N1152	115200

TABLE 9-7 Network/Serial Line Type Codes

Code	Meaning
Network Type Codes	
ENET	Ethernet
ANET	Arcnet
TRNG	Token ring
FDDI	Fiber distributed data interface
Serial Line Codes	
R232	Dedicated RS232 line
R423	Dedicated RS423 line
MODM	Dial-up (modem) line
Other Communication Type Codes	
I488	IEEE 488 (IEEE general purpose instrumentation bus)
IMIB	IEEE MIB (IEEE medical instrumentation bus)

TABLE 9-8 Device Type Codes

Code	Meaning
Storage Devices	
HD	Hard disk drive
F50	5-in. floppy disk drive
F35	3.5-in. floppy disk drive
OD	Optical disk drive
CD	CD-ROM drive
DV	DVD-ROM drive
CDW	CD-Writable drive
DVW	DVD-Writable drive
DT	DAT (digital audio tape) drive
M16	1600-bpi industry-standard magnetic tape drive
M62	6250-bpi industry-standard magnetic tape drive
CT	Cassette tape drive
HT	Helical scan tape drive
VT	Video tape drive
Printer/Display Devices	
CD	Color screen display
MD	Monochrome screen display
FP	Continuous form printer
MP	Monochrome sheet printer
CP	Color sheet printer

TABLE 9-9 Result Data Type Codes

Code	Meaning
	Result Information Categories
WAVE	Digital waveform data and associated labels (information categories described in Section 6)
ANNO	Annotations attached to digital waveform data and other primary data for the study (information categories described in Section 7)
RPRT	Report data (information categories described in Section 8)
	Result Coding
CODE	Alphanumeric codes are used in coded entry data
TEXT	Text descriptions are used in coded entry data

TABLE 9-10 Montage Data Type Codes

Code	Meaning
NAM	Montage definitions (number, name, and number of channels)
ELC	Montage and electrode definitions
CHN	Montage and channel definitions
SEL	Montage definitions and auxiliary montage selections
ALL	Montage, channel, and electrode definitions

TABLE 9-11 STA Category Result Segment Format

Components of Result Field	Type	Max length
System Function Identifier	ID	8
Current Function Status Code	ID	8
Additional Data 1	ST	200
Additional Data 2	ST	200
etc. ...		

TABLE 9-12 System Function Status Codes

Code	Meaning
A	Function is currently active
B	Function is beginning (start-up in progress)
C	Function is completing (termination in progress)
E	Function has been paused due to an error condition
I	Function is idle and available for remote **BEG** request
N	Function idle but not available for remote **BEG** request
P	Function has been paused due to a **PAU** request

TABLE 9-13 Error Codes and Messages

Code	Message	Code	Message
001	Missing message header segment	021	Required field absent: [segID], [seq#], [fld#]
002	Missing message trailer segment	022	Required component absent: [segID], [seq#], [fld#], [cmp#]
003	Unrecognized segment: [segID], [seq#]	023	Required subcomponent absent: [segID], [seq#], [fld#], [cmp#], [sub#]
004	Segment not allowed in this context: [segID], [seq#]	024	Segment sequence number out of sequence: [segID], [seq#]
005	Invalid character in message: [segID], [seq#], [fld#]		
006	Invalid delimiter in field: [segID], [seq#], [fld#]		
007	Invalid escape sequence in field: [segID], [seq#], [fld#]	301	Unknown test/observation ID code: [segID], [seq#], [fld#], [cmp#]
008	Invalid field format or data type: [segID], [seq#], [fld#]	302	Unknown information category: [segID], [seq#], [fld#], [cmp#], [sub#]
009	Repetition not allowed in field: [segID], [seq#], [fld#]		
010	Field too long: [segID], [seq#], [fld#]	303	Absent/out of sequence observation subID: [segID], [seq#], [fld#]
011	Component too long: [segID], [seq#], [fld#], [cmp#]	304	Probability not in range 0 to 1: [segID], [seq#], [fld#]
012	Subcomponent too long: [segID], [seq#], [fld#], [cmp#], [sub#]		
013	Invalid data for CK-type field: [segID], [seq#], [fld#]	401	Security field incorrect: [segID], [fld#]
014	Invalid data for ID-type field: [segID], [seq#], [fld#]	402	Unsupported message version ID: [segID], [fld#]
015	Invalid data for NM-type field: [segID], [seq#], [fld#]	403	Unsupported processing ID: [segID], [fld#]
016	Invalid data for TN-type field: [segID], [seq#], [fld#]	411	Error check byte incorrect: [segID], [seq#], [fld#]
017	Invalid data for TS-type field: [segID], [seq#], [fld#]	412	Error check code incorrect: [segID], [seq#], [fld#]
018	Too many fields in segment: [segID], [seq#], [fld#]	421	Patient count incorrect: [segID], [seq#], [fld#]
019	Too many components: [segID], [seq#], [fld#], [cmp#]	422	Line count incorrect: [segID], [seq#], [fld#]
020	Too many subcomponents: [segID], [seq#], [fld#], [cmp#], [sub#]	423	Batch number incorrect: [segID], [seq#], [fld#]

APPENDIX A – SNOMED TOPOGRAPHY CODES FOR NEUROPHYSIOLOGY

(Nonmandatory Information)

A.1 SNOMED (Systemized Nomenclature of Medicine) is a set of universal codes which may be used to standardize medical terminology. The SNOMED topography field is one of the seven currently defined axes of SNOMED. These codes provide a detailed and structured nomenclature for those parts of the body whose identification might reasonably be needed for the coding and retrieval of diagnostic and other medical data in a medical database.

A.2 The following is a list of those SNOMED topographic location codes which are most likely to be used in electroneurophysiology. These codes may be used to identify an electrode or transducer location, to define locations on the subject between which distances are measured, to specify the location of a stimulus delivered to the subject, or to identify the anatomic site (localization) which applies to a result or diagnosis. Although only a subset of the SNOMED codes for body regions, bones, brain regions, nerves, and muscles are given in A.6 and following, any of the topography field codes listed in the SNOMED handbook may be used in any of these contexts. The coding system described in this appendix represents extended SNOMED topographic location codes with optional qualifiers (coding system mnemonic identifier **SNM+**, specific code table identifier **TOPO**).

A.3 SNOMED codes do not provide enough specificity to uniquely identify the region or body part by such designations as left versus right, anterior versus posterior, medial versus lateral, or proximal versus distal, nor do they uniquely identify individual stimulation and recording sites along a nerve or individual members of a class (such as a particular cervical nerve). For this reason, the SNOMED codes for electroneurophysiologic studies may be extended by appending one or more qualifiers to the basic code (separated from the basic code and from each other by hyphens). The text corresponding to all of the qualifiers is concatenated in the order given, and this is prefixed to the text corresponding to the basic code to give the complete text description of the topographic location.

A.4 In some instances, basic SNOMED topographic codes do exist which *are* qualified by such designations. In these instances, it is preferable for consistency to use the unqualified or general SNOMED topographic code instead, adding the qualifiers in subsequent positions as would usually be done. For example, using the SNOMED code **T-Y0100** (head) together with the qualifier **LFT** (left), that is **T-Y0100-LFT** (left head), is preferable to using the SNOMED code **T-Y0102** (head, left side) with no qualifier.

A.5 In the following, NOS indicates *not otherwise specified*. Text in square brackets indicates comments on the topographic code which are *not* part of the actual text description of the topographic location.

A.6 *Basic SNOMED Topographic Codes*—The codes listed in A.6.1 through A.6.9 define the basic SNOMED codes for topographic locations.

A.6.1 *Cephalic Locations—General*:

Code	Meaning	Code	Meaning
T-Y0000	Head and neck [NOS]	T-Y0300	Cheek [NOS]
T-Y0100	Head [NOS]	T-Y0400	Cranial cavity [NOS; general intracranial locations]
T-Y0111	Frontal region	T-Y0410	Supratentorial region of cranial cavity
T-Y0120	Vertex (central) region	T-Y0420	Anterior fossa of cranial cavity
T-Y0130	Parietal region	T-Y0430	Middle fossa of cranial cavity
T-Y0140	Occipital region	T-Y0440	Infratentorial region of cranial cavity
T-Y0150	Temporal region	T-Y0450	Posterior fossa of cranial cavity
T-Y0160	Scalp [NOS; extracranial electrode/transducer locations]	T-Y0480	Orbital region [NOS]
T-Y0171	Preauricular area [10-20 reference point]	T-Y0490	Periorbital region
T-Y0200	Face [NOS]	T-Y0600	Neck [NOS]
T-Y0210	Chin		

A.6.2 *Cephalic Locations—Brain Structures and Special Sense Organs*:

Code	Meaning
T-X1400	Subdural space [NOS; subdural electrode locations]
T-X1420	Subdural space, frontal region
T-X1430	Subdural space, temporal region
T-X1440	Subdural space, parietal region
T-X1450	Subdural space, occipital region
T-X1600	Cerebral ventricle [NOS; intracranial pressure transducer location]
T-X1650	Lateral ventricle
T-X2020	Cerebral cortex [cortical depth electrode locations]
T-X2050	Brainstem
T-X2060	Cerebral hemisphere [NOS]
T-X2200	Frontal lobe [NOS]
T-X2210	Cortex of frontal lobe
T-X2220	White matter of frontal lobe
T-X2230	Superior frontal gyrus
T-X2232	Marginal gyrus
T-X2240	Middle frontal gyrus
T-X2251	Inferior frontal gyrus
T-X2260	Precentral gyrus
T-X2270	Paracentral lobule
T-X2280	Gyrus rectus
T-X2290	Orbital gyrus
T-X2300	Parietal lobe [NOS]
T-X2310	Cortex of parietal lobe
T-X2320	White matter of parietal lobe
T-X2330	Postcentral gyrus
T-X2340	Superior parietal lobule
T-X2350	Inferior parietal lobule
T-X2360	Precuneus
T-X2400	Occipital lobe [NOS]
T-X2410	Cortex of occipital lobe
T-X2420	White matter of occipital lobe
T-X2430	Area striata (visual cortex)
T-X2440	Calcarine fissure
T-X2450	Cuneus
T-X2460	Lingual gyrus
T-X2470	Lateral occipital gyrus
T-X2480	Superior occipital gyrus
T-X2490	Inferior occipital gyrus
T-X2500	Temporal lobe [NOS]
T-X2510	Cortex of temporal lobe
T-X2520	White matter of temporal lobe
T-X2530	Superior temporal gyrus
T-X2540	Middle temporal gyrus
T-X2550	Inferior temporal gyrus
T-X2560	Occipitotemporal gyrus
T-X2570	Hippocampus
T-X2573	Dentate gyrus
T-X2580	Hippocampal gyrus
T-X2590	Uncus of hippocampus
T-X2610	Insula [NOS]
T-X2620	Cortex of insula
T-X2630	White matter of insula
T-X2660	Gyrus longus
T-X2880	Optic radiation
T-X2890	Auditory radiation
T-X4230	Thalamus, posterolateral ventral nucleus
T-X4240	Thalamus, posteromedial ventral nucleus
T-X4380	Lateral geniculate body
T-X4390	Medial geniculate body
T-X5100	Midbrain [NOS]
T-X5150	Corpora quadrigemina, inferior colliculus
T-X5271	Medial lemniscus
T-X5272	Lateral lemniscus
T-X5400	Pons [NOS]
T-X7000	Medulla oblongata [NOS]
T-XX000	Eye [NOS; visual stimuli location]
T-XX200	Cornea [corneal electrode location]
T-XX813	Lateral canthus [eye movement electrode location]
T-XY000	Ear [NOS; auditory stimuli location]
T-XY105	Pinna of ear [ear electrode location]
T-XY200	External auditory canal [NOS]
T-XY320	Tympanic membrane [NOS; tympanic electrode location]

A.6.3 *Cephalic Locations—Bones Of Skull*:

Code	Meaning
T-10101	Skull [NOS; epidural electrode locations]
T-10107	Foramen ovale cranii [foramen ovale electrode location]
T-10110	Frontal bone [NOS]
T-10120	Parietal bone [NOS]
T-10130	Temporal bone [NOS]
T-10133	Mastoid process of temporal bone [common ground electrode location]
T-10140	Occipital bone [NOS]
T-10147	External occipital protuberance (inion) [10-20 reference point]
T-10156	Ethmoid bone [NOS; ethmoidal electrode location]
T-10159	Sphenoid bone [NOS; sphenoidal electrode location]
T-12171	Frontonasal suture (nasion) [10-20 reference point]

A.6.4 *Miscellaneous Locations*:

Code	Meaning
T-21000	Nose [NOS]
T-21310	Naris (nostril) [respiratory air flow monitor location]
T-23000	Nasopharynx [NOS; pharyngeal electrode location]
T-32200	Right atrium [intracardiac pressure transducer location]
T-44800	Peripheral pulmonary arteries [wedge pressure transducer location]
T-47300	Radial artery [arterial pressure transducer location]
T-48610	Superior vena cava [venous pressure transducer location]
T-51000	Mouth [NOS; respiratory air flow monitor location]

T-62000	Esophagus [NOS; temperature, pH, or pressure monitor location]
T-68000	Rectum [temperature or pressure monitor]
T-76000	Penis [nocturnal penile tumescence strain gage location]

A.6.5 *Noncephalic Locations—General*:

Code	Meaning	Code	Meaning	Code	Meaning
T-Y1000	Trunk [NOS]	T-Y8000	Upper extremity [NOS]	T-Y9000	Lower extremity [NOS]
T-Y1100	Back [NOS]	T-Y8100	Axilla [NOS]	T-Y9100	Thigh [NOS]
T-Y1200	Scapular region of back	T-Y8200	Upper arm [NOS]	T-Y9200	Knee [NOS]
T-Y1300	Lumbar region	T-Y8300	Elbow [NOS]	T-Y9300	Popliteal region
T-Y1400	Sacrococcygeal region	T-Y8400	Antecubital region	T-Y9400	Leg [NOS]
T-Y1500	Hip [NOS]	T-Y8500	Forearm [NOS]	T-Y9500	Ankle [NOS]
T-Y1600	Buttock [NOS]	T-Y8600	Wrist [NOS]	T-Y9600	Heel
T-Y1700	Perineum [NOS]	T-Y8700	Hand [NOS]	T-Y9700	Foot [NOS]
T-Y1800	Extremity [NOS]	T-Y8800	Finger [NOS]	T-Y9800	Toe [NOS]
T-Y2100	Thorax [NOS]	T-Y8810	Thumb [NOS]	T-Y9810	Great toe [NOS]
T-Y2400	Diaphragm [NOS]	T-Y8820	Index finger [NOS]	T-Y9820	Second toe [NOS]
T-Y4100	Abdomen [NOS]	T-Y8830	Middle finger [NOS]	T-Y9830	Third toe [NOS]
T-Y4300	Abdominal wall [NOS]	T-Y8840	Ring finger [NOS]	T-Y9840	Fourth toe [NOS]
T-Y6000	Pelvis [NOS]	T-Y8850	Little finger [NOS]	T-Y9850	Fifth toe [NOS]
T-Y7000	Inguinal region (groin) [NOS]				

A.6.6 *Noncephalic Locations—Specific Bones*:

Code	Meaning	Code	Meaning		
T-10520	Atlas [NOS]	T-10650	Fifth thoracic vertebra	T-10780	Fourth lumbar vertebra
T-10530	Axis [NOS]	T-10660	Sixth thoracic vertebra	T-10790	Fifth lumbar vertebra
T-10540	Third cervical vertebra	T-10670	Seventh thoracic vertebra	T-10800	Sacrum [NOS]
T-10550	Fourth cervical vertebra	T-10680	Eighth thoracic vertebra	T-10801	First sacral vertebra
T-10560	Fifth cervical vertebra	T-10690	Ninth thoracic vertebra	T-10802	Second sacral vertebra
T-10570	Sixth cervical vertebra	T-10700	Tenth thoracic vertebra	T-10803	Third sacral vertebra
T-10580	Seventh cervical vertebra	T-10710	Eleventh thoracic vertebra	T-10804	Fourth sacral vertebra
T-10610	First thoracic vertebra	T-10720	Twelfth thoracic vertebra	T-10805	Fifth sacral vertebra
T-10620	Second thoracic vertebra	T-10750	First lumbar vertebra	T-10830	Coccyx [NOS]
T-10630	Third thoracic vertebra	T-10760	Second lumbar vertebra	T-11310	Clavicle [NOS; Erb's point]
T-10640	Fourth thoracic vertebra	T-10770	Third lumbar vertebra	T-11339	Iliac crest

A.6.7 *Noncephalic Locations—Spinal Cord and Nerve Roots*:

Code	Meaning	Code	Meaning
T-X7410	Spinal cord [NOS]	T-X7720	Thoracic spinal cord, posterior horn
T-X7430	Spinal cord, posterior horn [NOS]	T-X7740	Thoracic spinal cord, ventral horn
T-X7460	Spinal cord, anterior horn [NOS]	T-X7760	Thoracic spinal cord, posterior column
T-X7480	Spinal cord, posterior column [NOS]	T-X7770	Thoracic spinal cord, lateral column
T-X7490	Spinal cord, lateral column [NOS]	T-X7780	Thoracic spinal cord, ventral column
T-X7493	Lateral corticospinal tract	T-X7790	Thoracic spine, nerve root
T-X7500	Spinal cord, anterior column	T-X7800	Lumbar spinal cord
T-X7560	Spinal nerve root [NOS]	T-X7810	Sacral spinal cord
T-X7561	Dorsal spinal nerve root	T-X7830	Lumbosacral spinal cord, posterior horn
T-X7562	Ventral spinal nerve root	T-X7850	Lumbosacral spinal cord, ventral horn
T-X7600	Cervical spinal cord [NOS]	T-X7870	Lumbosacral spinal cord, posterior column
T-X7620	Cervical spinal cord, posterior horn	T-X7880	Lumbosacral spinal cord, lateral column
T-X7640	Cervical spinal cord, ventral horn	T-X7890	Lumbosacral spinal cord, ventral column
T-X7660	Cervical spinal cord, posterior column	T-X7891	Lumbosacral spinal cord [NOS]
T-X7670	Cervical spinal cord, lateral column	T-X7892	Lumbosacral spinal cord, nerve root
T-X7680	Cervical spinal cord, ventral column	T-X7900	Cauda equina
T-X7690	Cervical spine, nerve root	T-X7910	Spinal nerve of cauda equina [NOS]
T-X7700	Thoracic spinal cord [NOS]	T-X7920	Conus medullaris

A.6.8 *Locations Near Peripheral Nerves*:

Code	Meaning
T-X8000	Cranial nerve [NOS]
T-X8040	Optic nerve [NOS]
T-X8070	Oculomotor nerve [NOS]
T-X8110	Trochlear nerve [NOS]
T-X8130	Abducens nerve [NOS]
T-X8150	Trigeminal nerve [NOS]
T-X8210	Ophthalmic nerve
T-X8242	Supraorbital nerve
T-X8260	Maxillary nerve
T-X8320	Infraorbital nerve
T-X8330	Mandibular nerve
T-X8410	Facial nerve [NOS]
T-X8500	Acoustic nerve [NOS]
T-X8530	Cochlear nerve
T-X8550	Vestibular nerve
T-X8570	Glossopharyngeal nerve [NOS]
T-X8640	Vagus nerve [NOS]
T-X8800	Accessory nerve, cranial portion
T-X8810	Accessory nerve, spinal portion
T-X8820	Hypoglossal nerve [NOS]
T-X9000	Spinal nerve [NOS]
T-X9001	Nerve [NOS]
T-X9031	Cervical nerve [NOS]
T-X9081	Phrenic nerve
T-X9090	Brachial plexus [NOS]
T-X9130	Long thoracic nerve
T-X9140	Musculocutaneous nerve
T-X9142	Lateral antebrachial cutaneous nerve
T-X9160	Medial antebrachial cutaneous nerve
T-X9170	Ulnar nerve [NOS]
T-X9172	Ulnar nerve, dorsal branch
T-X9174	Ulnar nerve, palmar branch [palm stimulation]
T-X9177	Ulnar nerve, proper digital palmar nerves [digit stimulation]
T-X9180	Median nerve [NOS]
T-X9185	Median nerve, palmar branch [palm stimulation]
T-X9188	Median nerve, proper digital palmar nerves [digit stimulation]
T-X9190	Radial nerve [NOS]
T-X9197	Radial nerve, superficial branch
T-X9200	Suprascapular nerve
T-X9210	Axillary nerve
T-X9230	Thoracic nerve [NOS]
T-X9300	Lumbar nerve [NOS]
T-X9320	Lumbar plexus
T-X9325	Iliohypogastric nerve
T-X9330	Lumbosacral plexus
T-X9340	Ilioinguinal nerve
T-X9360	Lateral femoral cutaneous nerve
T-X9370	Obturator nerve [NOS]
T-X9380	Femoral nerve
T-X9383	Saphenous nerve
T-X9400	Sacral nerve [NOS]
T-X9410	Sacral plexus
T-X9440	Sciatic nerve
T-X9450	Tibial nerve [NOS]
T-X9470	Sural nerve
T-X9483	Medial plantar nerve
T-X9486	Lateral plantar nerves
T-X9490	Common peroneal nerve
T-X9500	Deep peroneal (fibular) nerve
T-X9510	Superficial peroneal nerve
T-X9550	Pudendal nerve

A.6.9 *Locations Near Or In Muscles*:

Code	Meaning
T-13000	Skeletal muscle [NOS]
T-13100	Muscle of head [NOS]
T-13101	Splenius capitis muscle
T-13130	Longus capitis muscle
T-13142	Occipitofrontalis muscle, frontal belly
T-13150	Facial muscle [NOS]
T-13151	Depressor anguli oris muscle
T-13152	Risorius muscle
T-13153	Zygomaticus major muscle
T-13154	Zygomaticus minor muscle
T-13155	Levator labii superioris muscle
T-13156	Levator labii superioris alaeque nasi muscle
T-13157	Depressor labii inferioris muscle
T-13158	Levator anguli oris muscle
T-13159	Buccinator muscle
T-13160	Orbicularis oculi muscle [NOS]
T-13162	Orbicularis oculi muscle, orbital part
T-13170	Extrinsic ocular muscle [NOS]
T-13180	Superior rectus muscle
T-13190	Inferior rectus muscle
T-13200	Medial rectus muscle
T-13210	Lateral rectus muscle
T-13220	Superior oblique muscle
T-13230	Inferior oblique muscle
T-13243	Posterior auricularis muscle
T-13250	Mentalis muscle
T-13260	Masseter muscle
T-13270	Temporal muscle
T-13280	Pterygoid muscle [NOS]
T-13281	Lateral pterygoid muscle
T-13282	Medial pterygoid muscle
T-13290	Orbicularis oris muscle
T-13300	Muscle of neck [NOS]
T-13301	Splenius cervicis muscle
T-13310	Sternocleidomastoid muscle
T-13330	Digastric muscle
T-13331	Digastric muscle, anterior belly
T-13332	Digastric muscle, posterior belly
T-13350	Mylohyoid muscle [submental EMG electrodes]
T-Y2400	Diaphragm [NOS; SNOMED lists as a topographic region, not a muscle]
T-13480	Platysma muscle
T-13490	Laryngeal muscle [NOS]
T-13492	Cricothyroid muscle
T-13497	Thyroarytenoid muscle
T-13510	Intrinsic lingual muscle [NOS]
T-13520	Genioglossus muscle
T-13600	Muscle of upper extremity [NOS]
T-13610	Supraspinatus muscle
T-13620	Infraspinatus muscle
T-13630	Teres minor muscle
T-13640	Teres major muscle
T-13650	Subscapularis muscle
T-13660	Deltoid muscle
T-13670	Biceps brachii muscle
T-13680	Brachialis muscle
T-13690	Triceps brachii muscle
T-13691	Triceps brachii muscle, long head
T-13692	Triceps brachii muscle, lateral head
T-13693	Triceps brachii muscle, medial head
T-13710	Coracobrachialis muscle
T-13720	Anconeus muscle
T-13740	Pronator teres muscle
T-13750	Flexor carpi radialis muscle
T-13760	Palmaris longus muscle
T-13770	Flexor carpi ulnaris muscle
T-13781	Flexor digitorum superficialis muscle
T-13784	Flexor digitorum profundus muscle
T-13790	Flexor pollicis longus muscle
T-13810	Pronator quadratus muscle
T-13820	Brachioradialis muscle
T-13831	Extensor carpi radialis longus muscle
T-13832	Extensor carpi radialis brevis muscle
T-13840	Extensor digitorum muscle
T-13842	Extensor digiti minimi muscle
T-13850	Extensor carpi ulnaris muscle [NOS]
T-13860	Supinator muscle
T-13870	Palmaris brevis muscle

T-13881	Abductor pollicis longus muscle
T-13882	Abductor pollicis brevis muscle
T-13890	Flexor pollicis brevis muscle
T-13911	Extensor pollicis brevis muscle
T-13912	Extensor pollicis longus muscle
T-13913	Extensor indicis muscle
T-13920	Opponens pollicis muscle
T-13930	Adductor pollicis muscle
T-13940	Abductor digiti minimi muscle of hand
T-13950	Flexor digiti minimi brevis muscle of hand
T-13960	Opponens digiti minimi muscle of hand
T-13970	Lumbrical muscles of hand
T-13981	Dorsal interosseous muscles of hand
T-13982	Palmar interosseous muscles of hand
T-14000	Muscle of trunk [NOS]
T-14010	Splenius muscle of trunk
T-14020	Erector spinae muscle
T-14050	Spinalis muscle [NOS]
T-14051	Spinalis thoracis muscle
T-14052	Spinalis cervicis muscle
T-14053	Spinalis capitis muscle
T-14061	Semispinalis muscle [NOS]
T-14062	Semispinalis thoracis muscle
T-14063	Semispinalis cervicis muscle
T-14064	Semispinalis capitis muscle
T-14065	Multifidus muscles
T-14070	Interspinalis muscles [NOS]
T-14071	Interspinalis cervicis muscles
T-14072	Interspinalis thoracis muscles
T-14073	Interspinalis lumborum muscles
T-14090	Muscle of back [NOS]
T-14091	Muscle of lower back [NOS]
T-14100	Muscle of thorax [NOS]
T-14110	Pectoralis major muscle [NOS]
T-14120	Pectoralis minor muscle
T-14130	Subclavius muscle
T-14140	Serratus anterior muscle
T-14160	Intercostal muscle [NOS]
T-14170	Muscle of upper back [NOS]
T-14171	Trapezius muscle
T-14172	Latissimus dorsi muscle
T-14173	Rhomboid major muscle
T-14174	Rhomboid minor muscle
T-14180	Levator scapulae muscle
T-14190	Serratus posterior muscle [NOS]
T-14200	Muscle of abdomen [NOS]
T-14220	Obliquus externus abdominis muscle
T-14230	Obliquus internus abdominis muscle
T-14250	Transversus abdominis muscle
T-14260	Rectus abdominis muscle
T-14270	Quadratus lumborum muscle
T-14300	Muscle of perineum [NOS]
T-14313	Puborectalis muscle
T-14320	Coccygeus muscle
T-14330	Sphincter ani muscle [NOS]
T-14332	Sphincter ani externus muscle [NOS]
T-14400	Muscle of hip and thigh [NOS]
T-14410	Iliopsoas muscle [NOS]
T-14420	Obturator muscle [NOS]
T-14430	Gluteus maximus muscle
T-14440	Gluteus medius muscle
T-14450	Gluteus minimus muscle
T-14451	Tensor fasciae latae muscle
T-14460	Piriform muscle
T-14470	Gemellus muscle [NOS]
T-14480	Quadratus femoris muscle
T-14490	Sartorius muscle
T-14510	Adductor brevis muscle
T-14520	Adductor longus muscle
T-14530	Adductor magnus muscle
T-14540	Gracilis muscle
T-14550	Quadriceps femoris muscle
T-14560	Rectus femoris muscle
T-14570	Vastus lateralis muscle
T-14580	Vastus medialis muscle
T-14610	Pectineus muscle
T-14620	Vastus intermedius muscle
T-14630	Biceps femoris muscle
T-14631	Biceps femoris muscle, long head
T-14632	Biceps femoris muscle, short head
T-14640	Semimembranosus muscle
T-14650	Semitendinosus muscle
T-14700	Muscle of leg [NOS]
T-14710	Popliteal muscle
T-14720	Triceps surae muscle
T-14730	Gastrocnemius muscle
T-14731	Gastrocnemius muscle, lateral head
T-14732	Gastrocnemius muscle, medial head
T-14740	Soleus muscle
T-14750	Plantaris muscle
T-14760	Tibialis anterior muscle
T-14770	Tibialis posterior muscle
T-14780	Extensor digitorum longus muscle
T-14781	Extensor digitorum brevis muscle
T-14790	Extensor hallucis longus muscle
T-14791	Extensor hallucis brevis muscle
T-14810	Peroneus muscle [NOS]
T-14811	Peroneus longus muscle
T-14812	Peroneus brevis muscle
T-14820	Flexor digitorum longus muscle
T-14900	Muscle of foot [NOS]
T-14910	Abductor digiti minimi muscle of foot
T-14920	Quadratus plantae muscle
T-14930	Lumbricales pedis muscles
T-14940	Flexor hallucis brevis muscle
T-14950	Adductor hallucis muscle
T-14960	Flexor digiti minimi brevis muscle of foot
T-14970	Interosseous plantares muscles
T-14980	Interosseous dorsales muscles
T-14990	Abductor hallucis muscle

A.7 *Qualifiers for SNOMED Topographic Codes*—The codes listed in Table A-1 are used to qualify the basic SNOMED topographic location codes. They may be appended to the basic code in any order, and are separated from the basic code and from each other by hyphen (-) characters.

A.8 The **LC1** to **LC9** qualifiers (used with topographic codes for nerves) represent conventional stimulation and recording sites for nerve conduction studies (NCS). **LC1** represents a CNS site associated with the nerve (for example, contralateral motor cortex for motor NCS on median nerve). **LC2** represents a nerve root site (for example, C8 root for motor NCS on ulnar nerve). **LC3** represents a site near the plexus or very proximal portion of the nerve (for example, the supraclavicular area for motor NCS on median nerve, or the lumbar spine for motor NCS on tibial nerve). Location qualifiers **LC4** through **LC9** denote sites along nerves in the extremities. Proximal arm often refers to the axilla, and proximal thigh to the groin. Distal arm often refers to the elbow, distal thigh to the knee, distal forearm to the wrist, and distal leg to the ankle. Nerve location qualifiers for palm/sole and digit sites are not needed since separate SNOMED codes exist for the palmar/plantar and digital nerves. The notations proximal, intermediate, and distal have different meanings for different nerves (for example, for common peroneal nerve/extensor digitorum brevis motor NCS, the usual proximal leg site would be distal to the head of the fibula and the distal leg site would be at the ankle; for sural nerve sensory NCS, the proximal, intermediate, and distal leg sites could all be in the lower calf above the ankle at three equally spaced points along the nerve). For simplicity of implementation, the text associated with the **LC4** to **LC9** qualifiers applies to nerves in either the upper or lower extremity; if desired, a more complex implementation could be designed to select appropriate text for such a qualifier based on whether it was used with a base SNOMED topographic code for an upper or a lower extremity nerve (for example, **LC9** would be interpreted as *distal forearm portion* when applied to the median nerve, but as *distal leg portion* when applied to the common peroneal nerve).

A.9 The **N##** qualifiers (**N1**, **N2**, **N3**, etc.) are used when the topographic location code in the first subcomponent must be further qualified because multiple such body parts or regions exist (for example, SNOMED code **T-X9031**, cervical nerve, can be qualified by the **N5** qualifier, to indicate the fifth cervical nerve; SNOMED code **T-X7560**, spinal nerve root, may be qualified by the **N21** qualifier, to indicate the twenty-first spinal nerve root, that is the first lumbar root). When it is desired to explicitly indicate multiple body parts or regions (for example, multiple cervical nerves), the qualifier **MLT** may be used.

TABLE A-1 SNOMED Topographic Location Qualifiers

Qualifier		Meaning			
LFT	Left	LAT	Lateral	LC2	Root portion [of nerve]
RGT	Right	PRX	Proximal	LC3	Plexus portion [of nerve]
MID	Midline	INT	Intermediate	LC4	Proximal arm/thigh portion [of nerve]
BIL	Bilateral	DST	Distal	LC5	Intermediate arm/thigh portion [of nerve]
ANT	Anterior	DEP	Deep	LC6	Distal arm/thigh portion [of nerve]
PST	Posterior	SPF	Superficial	LC7	Proximal forearm/leg portion [of nerve]
SUP	Superior	BEL	Belly [of muscle]	LC8	Intermediate forearm/leg portion [of nerve]
INF	Inferior	INS	Insertion [of muscle]	LC9	Distal forearm/leg portion [of nerve]
MED	Medial	LC1	CNS connections [of nerve]	N##	Number ## [## is a one- or two-digit number, 1 to 99]
				MLT	Multiple

APPENDIX B — Technical Standard 1 Coding Systems for Neurophysiology

B.1 The following are descriptions of several alphanumeric coding systems designed for use in electroneurophysiology. These coding systems apply to electroencephalogram (EEG) and magnetoencephalogram (MEG) studies, polysomnogram (PSG) and multiple sleep latency test (MSLT) studies, nerve conduction studies (NCS), electromyogram (EMG) studies, and evoked potential (EP), event-related potential (ERP), and evoked magnetic field (EMF) studies. The various coding systems described in this appendix all represent Technical Standard 1 universal codes (coding system mnemonic identifier **AS4**), but each has its own specific code table identifier as described in this appendix.

B.1.1 One set of alphanumeric codes defined in this appendix may be used to code individual qualitative test results or to grade individual quantitative test results (referred to as coded entry or CE type results) that pertain to an electroneurophysiologic study. These include a set of codes which may be used to specify the distribution (anatomic site) of waveforms or activities seen in some electroneurophysiologic studies; these codes are an alternative to other universal coding schemes for anatomic localizations, such as SNOMED topographic codes. Another set of codes (the test/observation ID codes) may be used to identify specific electroneurophysiologic tests or studies or specific test results, or both. Finally, alphanumeric codes are described for expressing diagnostic impressions that apply to electroneurophysiologic studies; these codes convey the salient features of the study, and represent an alternative or addition to the local coding schemes for diagnoses used in many electroneurophysiology laboratories and to universal coding schemes for clinical diagnoses such as ICD-9-CM or ICSD.

B.1.2 The codes are constructed in such a way as to be translatable into a unique text description of the test result, test identifier, distribution or anatomic site, or diagnostic impression. This system of alphanumeric codes lends itself to computerized database applications in that automatic searches for particular categories may be performed easily. Codes or portions of codes with generic meanings are listed as [unspecified], and codes or portions of codes listed as [reserved] are reserved for future use. In displays and reports, the text associated with such codes or portions of codes is the null string (unless edited as described in B.1.3). In general, text in square brackets indicates comments in this Technical Standard which are *not* part of the actual text description of a code.

B.1.3 The standard coding systems described in this appendix are not intended to satisfy the needs of all laboratories for all clinical and research-oriented studies. However, they should be general enough to cover the practices of most clinical studies in most laboratories. It is suggested that implementations of this coding system should allow each laboratory to customize the text descriptions associated with the codes according to local usage. That is, as long as the general meaning of the code is not changed significantly, its associated text used in display and report generation may be altered. For some tests (such as evoked potentials), the methodology differs significantly in various laboratories so that customization of the text descriptions (for example, the names of the EP peaks) may be necessary in most cases. If it is necessary to add one or more codes for tests, test results, or diagnoses not currently included in the standard coding systems, it is recommended that new codes or portions of codes be defined using *alphabetic* characters to distinguish them from the mostly *numeric* digits used in the current standard. Future versions of this Technical Standard may use alphabetic characters in codes in a way that could preempt the nonstandard meanings attached to them by existing applications; using the letters at the end of the alphabet for user-defined codes would minimize the chance of preemption by future Technical Standards. For example, suppose that a laboratory uses the following peaks in tibial SEP studies: popliteal, lumbar, cervical, N33, P38, N46, P58 (single peaks); popliteal-lumbar, lumbar-cervical, cervical-P38, lumbar-P38 (sets of peaks). This laboratory could redefine the peak identifiers so that 3 = *cervical peak*, 4 = *P38 peak*, 5 = *N46 peak*, 6 = *P58 peak*, 7 = *lumbar-cervical peak*, 8 = *cervical-P38 peak*, 9 = *lumbar-P38 peak* (since these meanings are quite similar to the standard meanings) and add new identifiers Y = *N33 peak* and Z = *popliteal-lumbar peak*. Finally, laboratories which now have or want to develop their own local coding system as an alternative to the coding systems described in this appendix may certainly do so; these local coding systems may be similar to or may differ substantially from the standard coding systems. However, the primary disadvantage of local coding systems, their lack of universality, is a consideration when exchanging electroneurophysiologic data between different laboratories or institutions. Finally, it should be noted that many laboratories may not wish to code diagnoses or test results at all, but instead will use free-format text descriptions in their reports and databases; these laboratories need not implement either the coding systems described in this appendix or a local coding system for diagnoses and test results.

Universal Test/Observation ID Codes

B.2 The test/observation ID codes described in this appendix may be used to specify a specific test to be performed by a laboratory or to specify a particular test for which results are needed. They may also be used to identify specific tests and test results in a database. The specific code table identifier for the test/observation ID codes is **TEST**.

B.2.1 Except for the body temperature codes defined in B.7, the universal test/observation ID codes are based on five character CPT-4 codes, with an optional two character modifier appended (following a hyphen). For example, the CPT-4 code 95816 indicates a routine EEG; the code 95816-26 indicates routine EEG interpretation only (that is, interpretation of a previously performed EEG). However, since CPT-4 codes do not provide enough specificity to uniquely identify tests, portions of tests, and individual quantitative and qualitative test results, these codes extend the basic CPT-4 codes for electroneurophysiologic studies by appending an additional code of up to eleven characters (following a period) to the CPT-4 code. The first four or five characters following the period identify a portion of the study with particular recording (or stimulating) conditions; the next four characters identify a specific data sample (epoch or trial) or a statistical measure calculated from multiple data samples; the last one to three characters identify an individual test result. When a CPT-4 modifier as well as an extension code is required, the modifier is given first; for example, the code 95816-26.0101 refers to the portion of an outside EEG recording being interpreted in which the subject was awake with eyes closed.

B.2.2 The four character codes in Table B-1 may be used as part of the test/observation ID code for all classes of electroneurophysiologic studies to identify a particular data sample (epoch or trial) or a statistical measure calculated from multiple data samples.

B.2.3 In Table B-1, code 0000 is used when it is not necessary to identify a particular data sample. Codes 0001 to 9900 (used to identify individual samples) may or may not be followed by additional characters specifying an individual test result; when they are, they indicate the data sample to which the individual result applies. Codes 9902 to 9999 identify individual statistical measures and are always followed by additional characters specifying an individual test result to which the statistical measure applies (for example, alpha activity frequency in an EEG, or motor unit duration in an EMG). Code 9906 and 9907 are used to identify, for example, the lower and upper bounds of a 95% confidence interval for the result. Code 9908 represents the fraction of samples for which the measured value was outside of the normal limits for the laboratory; this fraction may be expressed as a unitless number or as a percentage (units = %). Code 9901 specifies the number of data samples used to calculate the statistical measures specified by codes 9902 to 9999; it is never followed by additional characters specifying an individual test result.

B.2.4 When a CPT-4 code with an added extension code is used when ordering tests, the intention is that only the indicated subtest or portion of the study need be performed, or that only data from the indicated subtest or portion of the study or individual quantitative or qualitative test result need be supplied. When a CPT-4 code with an added extension code is used to label certain results of a study such as a textual report or interpretation, the implication is that the report or other result so labeled pertains to the indicated subtest or portion of the total study. A CPT-4 code with an added extension code may also be used to identify an individual quantitative or qualitative test result; in this situation, the extension code must uniquely identify the individual result of the study (which may be associated with certain normal values for the laboratory). To accomplish this, the extension codes in the test/observation IDs associated with individual test results contain more characters and are more selective than those which identify a portion of a study, which in turn contain more characters and are more selective than those which identify an entire test or study.

B.2.5 When a less selective test/observation ID code that identifies an entire study (for example, one with no extension code) is used when ordering tests, the intention is that all subtests or portions of the study that are indicated for the clinical situation or normally performed in that laboratory should be performed, or that all available data from the study should be supplied. When a generic test/observation ID code that identifies an entire class of studies (for example, code 9581X which may be used to indicate a variety of individual EEG studies) is used when ordering tests, the intention is that all studies that are indicated for the clinical situation or normally performed in that laboratory should be performed, or that all available data from all studies performed should be supplied. When a less selective test/

observation ID code that identifies an entire study is used to label certain results of a study such as a report or diagnosis, the implication is that the report or other result so labeled applies to the entire study and not to a particular subtest or portion thereof. When a generic test/ observation ID code that identifies an entire class of studies is used to label results such as a report or diagnosis, the implication is that the result so labeled applies to all studies actually performed and not to one particular study or portion thereof. Paragraphs B.3 through B.7 define test/observation ID codes for the various classes of electroneurophysiologic studies.

B.3 *Test/Observation ID Codes for EEG and Related Studies*—The test/observation ID codes for EEG and related studies are constructed by adding extension codes defined in B.3.2 through B.3.6 to CPT-4 codes, to identify portions of the study during which specific procedures were performed and during which the subject had a particular state of consciousness and state of eye closure, a specific sample (epoch) number (when needed), and individual quantitative or qualitative test results pertaining to the recording. Complete codes of the form **95ttt.ssccnnnnwwv** are used to fully identify an individual test result. Here, **ttt** is a three character test identifier, **ss** is a two character section of recording identifier, **cc** is a two character state of consciousness/eye closure identifier, **nnnn** is a four character epoch number, **ww** is a two character waveform/activity or special parameter identifier, and **v** is a one character value identifier. Less complete (less selective) codes of the form **95ttt.ssccnnnn** or **95ttt.sscc** are used to identify sections of the recording and states of consciousness (and specific epochs, if needed). For example, codes of the form **95ttt.sscc** may be used to specify the type and portion of a study to which one of the EEG diagnostic codes (coding system **EEGD**) described in B.11.2 applied. Unqualified CPT-4 codes of the form **95ttt** are used to refer to the entire recording.

B.3.1 *CPT-4 Codes for EEG and Related Studies*—These five character codes (**95ttt**) listed in Table B-2 identify basic types of electroencephalogram (EEG), polysomnogram (PSG), multiple sleep latency tests (MSLT), multiple channel surface electromyogram recordings (SEMG), and related studies. Code 95805 (MSLT) may also be used for maintenance of wakefulness tests (MWT) and similar procedures used to investigate excessive daytime sleepiness. Polysomnography (codes 95808 and 95810) is distinguished from sleep studies (code 95807) by the inclusion of sleep staging (see CPT-4). Code 9581X is a generic EEG laboratory test code, which may be used to order awake or sleep EEG recordings or similar studies according to the clinical indications and local norms. Code 9580X is a generic sleep laboratory test code, which may be used to order sleep studies, polysomnograms, MSLTs, or MWTs, according to the clinical indications and local norms. Code 95999 (unlisted neurological or neuromuscular diagnostic procedure) has been assigned for surface EMG (SEMG) recordings, usually with multiple channels.

B.3.2 *EEG Section of Recording Identifiers*—The two character codes (**ss**) in Table B-3 identify a portion of an EEG/MEG, PSG/MSLT, or SEMG recording. Code 93 is used to identify a biocalibration recording during which all channels were connected to the same physiologic signal; codes 91 and 92 are used to identify a calibration recording during which all channels received a square wave or sinusoidal calibration signal.

B.3.3 *EEG State of Consciousness/Eye Closure Identifiers*—These two character codes (**cc**) identify the state of consciousness of the subject or the type of seizure or other observed activity which the subject manifests, as well as the state of opening/closure of the subject's eyes during an EEG/MEG, PSG/MSLT, or SEMG recording. These codes may be used if the clinical state of the subject is known and relevant, or code 00 may be used if it is not necessary to specify the subject's state. Codes 10 to 49 (seizure types) take priority over codes 01 to 09 (states of consciousness). The codes in Table B-4 may be used; alternatively, codes 51 to 99 may be used, which are the same as codes 01 to 49 except that *eyes open* replaces *eyes closed* in the text description.

B.3.4 *EEG Epoch Number*—This four character code (**nnnn**) identifies a particular epoch (data sample) within a section of an EEG/MEG, PSG/MSLT, or SEMG recording, or specifies a type of statistical measure which was derived from observations on multiple epochs. For example, in EEG/MEG recordings, this code could be used to identify an epoch upon which spectral analysis was performed and, in conjunction with the waveform/activity and value identifier characters which follow, to identify the individual frequency and amplitude values which apply to that epoch or specify statistical measures for the frequency and amplitude values. In PSG/MSLT recordings, this code could be used to identify an epoch upon which sleep stage scoring was performed and, along with the waveform/activity and value identifier characters which follow, to identify the characteristics of the specific sleep activity seen in that epoch. The codes described in Table B-1 are used.

B.3.5 *EEG Waveform/Activity or Special Para-*

meter Identifiers—These two character codes (**ww**), when followed by a non-zero one character value identifier, are used to identify particular waveforms or activities of cerebral or noncerebral origin or particular events of diagnostic significance in the EEG/MEG, PSG/MSLT, or SEMG recording. Alternatively, when followed by a zero, they identify sleep or cardiorespiratory parameters.

B.3.5.1 *EEG Waveform/Activity Identifiers*—The waveform/activity identifiers which are used in conjunction with a subsequent nonzero value identifier are given in Table B-7; a value of 00 is used to refer to the recording as a whole.

B.3.5.2 *EEG Special Parameter Identifiers*—The special parameter identifiers which are used with a subsequent value identifier of zero to identify a special sleep or cardiovascular parameter monitored are given in Table B-5, along with the usual grading or coding system used for each coded entry result (CE).

B.3.5.3 The parameters listed in Table B-5 other than *sleep stage* and *heart rhythm* may be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10.2, or as actual numeric values and their units, or both. The *heart rhythm* and *sleep stage* parameters can only be specified as coded entries, using the appropriate coding systems described in B.9.2 and B.9.3, respectively. Examples of numeric results which may be given for the other parameters and their appropriate units are as follows. *Respiratory air flow* can be measured by various devices (units = *l*/min, for example). *Ventilatory effort* can also be measured in various ways, such as an intraesophageal pressure monitor; units = pal (pascal) or mm(hg). *Oxygen saturation* can be measured by an oximeter (units = %). *Heart rate* is measured by an EKG monitoring device (units = /min or min-1). *Blood pressure* can be measured by an arterial line pressure transducer or by cuff; units = pal or mm(hg). *Intracranial pressure* can be measured by a pressure transducer; units = pal or mm(hg).

B.3.6 *EEG Value Identifiers*—These one character codes (**v**) identify particular characteristics of the EEG/MEG, PSG/MSLT, or SEMG waveforms, activities, or events described in B.3.5.1. An individual quantitative or qualitative EEG test result (other than the special sleep and cardiorespiratory parameters described in B.3.5.2) may be identified by the combination of a waveform/activity and a value (characteristic), for example, *alpha activity amplitude*. The value identifier codes are given in Table B-6, along with the usual grading or coding system (described in B.9 and B.10) used for each coded entry result (CE).

B.3.6.1 The parameters listed in Table B-6 other than *waveform characteristics* and *distribution* may be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10, or as actual numeric values and their units (estimated from visual inspection or determined by computer processing), or both. The *waveform characteristics* and *distribution* parameters can only be specified as coded entries, using the appropriate coding systems described in B.9 or (for the *distribution* parameter) the SNOMED topographic coding system. Examples of numeric results which may be given for the other parameters and their appropriate units are as follows:

B.3.6.2 *Abundance* (also known as *quantity*) refers to the fraction of the entire recording time occupied by the specified waveforms, activity, events, or sleep/wake stage. It may be a unitless number in the range from 0 to 1, or a percentage (units = %) in the range from 0 to 100. For waveforms, bursts, or events which are non-overlapping, abundance is equal to repetition rate (frequency) times average duration.

B.3.6.3 *Amplitude* may refer to the peak-to-peak amplitude (that is, voltage or magnetic field strength) of a particular activity or waveform or all activity in a given sleep/wake stage determined by visual inspection (units = uv or mv for EEG, ft = femptotesla for MEG) or, when used to report spectral analysis results, to the calculated power (units = uv2/hz or mv2/hz) or square root of power (units = uv/hz0.5 or mv/hz0.5) in a particular frequency band (alpha, beta, etc.), sleep stage, or epoch.

B.3.6.4 *Frequency*, for waveform/activity codes 10 to 21 and other rhythmic activities, refers to the frequency of the rhythm (units = hz), derived from visual inspection or spectral analysis (for example, peak or mean frequency in a particular frequency band or of all activity). For other waveform/activity identifiers describing transient waveforms, bursts, events, or sleep/wake stages, it refers to the repetition rate or occurrence rate of the phenomenon (units = hz, /min, /hr, or /d) or to the total number of occurrences of the phenomenon during the recording (unitless).

B.3.6.5 *Duration* refers to the time from onset to end of the waveform, activity, event, or sleep/wake stage (units = ms, s, min, or hr).

B.3.6.6 *Asymmetry* is usually calculated as the difference in amplitude of the activity or waveforms between homologous regions on the left and on the right side of the head, divided by the larger of the left or right sided amplitude. It may be expressed as a unitless number (range from 0 to 1) or as a percentage (units = %).

B.3.6.7 *Reactivity* refers to the change in amplitude of the activity or waveform in response to some stimulus or state change (such as eye opening). It may be calculated as the difference between the old and new amplitude divided by the old amplitude. It may be expressed as a unitless number (range from 0 to 1) or as a percent (units = %).

B.3.6.8 *Latency* refers to the elapsed time from some reference point (such as the start of the recording, or the beginning of sleep) to the occurrence or onset of the activity, waveform, sleep stage, or event (units = s, min, or hr).

B.3.6.9 Any results in B.3.6.2 through B.3.6.8 may apply to a single epoch (which may be specified, if necessary, in the epoch number portion of the test/observation ID code) or may be a statistical measure (mean, minimum, maximum, standard deviation, etc.) calculated from multiple epochs.

B.3.7 *Examples of Test/Observation ID Codes for EEG and Related Studies*—This scheme for classifying EEG and related tests does not imply that any or all of the combinations of the codes in B.3.1 through B.3.6 define values that are useful or need be reported for any given study in any laboratory. However, the scheme is general enough to cover the practices of most laboratories, and an alphabetic character for each type of identifier may be used to represent categories which are not otherwise representable in this scheme.

B.3.8 Table B-8 and Table B-9 present some examples of test/observation ID codes for EEG and PSG studies, respectively, and indicate in the comments how the coding system may be used to represent various commonly calculated sleep parameters.

B.4 *Test/Observation ID Codes for EMG and Related Studies*—The test/observation ID codes for EMG (needle examination of individual muscles) and related studies are constructed by adding extension codes defined in B.4.2 through B.4.5 to CPT-4 codes, to identify specific muscles studied, a specific sample number (when needed), and individual quantitative or qualitative test results pertaining to the study. Complete codes of the form **ttttt.mmmmnnnnwwv** are used to fully identify an individual test result. Here, **ttttt** is a five character test identifier, **mmmm** is a four character muscle identifier, **nnnn** is a four character sample number, **ww** is a two character waveform/activity identifier, and **v** is a one character value identifier. Less complete (less selective) codes of the form **ttttt.mmmmnnnn** or **ttttt.mmmm** are used to identify muscles tested (and specific samples of activity, if needed). Unqualified CPT-4 codes of the form **ttttt** are used to refer to the entire study. For example, codes of the form **ttttt** may be used to specify the type of study to which an EMG diagnostic code (coding system **EMGD**) described in B.11.3 applied.

B.4.1 *CPT-4 Codes for EMG and Related Studies*—The five character codes (**ttttt**) listed in Table B-10 identify basic types of EMG and single fiber EMG studies. Code 9586X is a generic EMG laboratory test code which can be used to order motor, sensory, or special nerve conduction studies, or combination thereof, together with appropriate standard, single fiber, or special EMG studies chosen according to the clinical indications and local norms.

B.4.2 *EMG Muscle Identifiers*—These four character codes (**mmmm**) identify the specific muscle recorded from. The first character of the four character code identifies the side (left or right) and general location of the muscle recorded from, as in Table B-11.

B.4.2.1 The remaining three characters of the four character code are derived from the last three characters of the SNOMED topographic codes **T-13###** (muscles of head, neck, mouth, and upper extremity) and **T-14###** (muscles of trunk, perineum, and lower extremity). The three characters 000 indicate an unspecified muscle. The diaphragm is represented as 0400 (left diaphragm) or 2400 (right diaphragm).

B.4.3 *EMG Sample Number*—This four character code (**nnnn**) identifies a particular sample of muscle electrical activity made at one site in the specific muscle tested, or specifies a type of statistical measure which was derived from observations at multiple sites. For example, in conjunction with the waveform/activity identifiers and value identifier characters which follow, these four characters could identify the particular motor unit to which individual motor unit potential amplitude or duration values apply, or specify statistical measures (such as mean amplitude or duration) based on all of the motor units seen at different sites. The codes described in Table B-1 are used.

B.4.4 *Standard EMG Waveform/Activity Identifiers*—The two character codes (**ww**) in Table B-12, which are used with CPT-4 codes other than 95872 (single fiber EMG), identify particular waveforms, iterative discharges, or activities observed during needle examination of a muscle; code 00 must be used with CPT-4 code 95872 (single fiber EMG).

B.4.5 *EMG Value Identifiers*—These one character codes (**v**) identify particular characteristics of EMG waveforms, activities, iterative discharges, or single fiber discharges. An individual quantitative or qualitative EMG test result is identified by the combination of a waveform/activity and a value (characteristic), for example, *motor unit potentials amplitude*. The meaning of these codes depends on the particular EMG study specified by the CPT-4 code.

B.4.5.1 *Standard EMG Value Identifiers*—The value identifiers which may be used with CPT-4 codes other than 95872 (single fiber EMG) and with a nonzero waveform/activity identifier to identify particular characteristics of the EMG waveforms, iterative discharges, or activities are given in Table B-13, along with the usual grading or coding system (described in B.9 and B.10) used for each coded entry result (CE). The grading system used for codes one to eight depends on the preceding two character waveform/activity code; a relative grading system (**RELA**) is used for characteristics of potentials under voluntary control (graded according to what is normal for the particular muscle), while an absolute or relative grading system (**LOHI**, **SHLO**, **SMLG**, or **ABUN**) is used for other waveforms/activities except insertional activity abundance, which uses relative grading.

B.4.5.2 The parameters listed in Table B-13 other than *firing pattern* may be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10, or as actual numeric values and their units, or both. The *firing pattern* parameter can only be specified as a coded entry, using the appropriate coding system described in B.9.5. Examples of numeric results which may be given for the other parameters and their appropriate units are as follows:

B.4.5.3 *Abundance* refers to the fraction of the entire recording time occupied by the specified waveforms, discharges, or activity. It may be a unitless number in the range from 0 to 1, or a percentage (units = %) in the range from 0 to 100. For waveforms or discharges which are non-overlapping, abundance is equal to repetition rate (frequency) times average duration. For potentials under voluntary control, abundance is replaced by activation, the ability to cause voluntary firing, which may range from 0, indicating no units under voluntary control, to 1 (100 when units = %), indicating normal or complete activation. *Amplitude* refers to the peak-to-peak amplitude of a particular waveform, discharge, or activity (units = uv or mv), while *area* refers to the area under the waveform or discharge (units = uv.ms or mv.ms). *Frequency* refers to the repetition or occurrence rate of the waveform or discharge (units = hz or /min). *Duration* refers to the time from onset to end of the waveform or discharge (units = ms or s). *Complexity* refers to the number of phases (units = pha) or turns (units = tur) in the waveform.

B.4.5.4 *Variability* refers to the change in shape or size of the waveform or discharge over multiple consecutive firings and can be expressed as the standard deviation of the amplitude (units = uv or mv) or area (units = uv.ms or mv.ms) in multiple firings. *Rise time* refers to the time from onset to peak of the waveform, discharge, or activity (units = us or ms). *Recruitment* (used instead of frequency for potentials under voluntary control) can be expressed as the number of units firing divided by the firing frequency of the fastest unit (units = /hz; used in situations of decreased motor unit availability) or the number of units firing divided by the force generated by the muscle (units = /g; used in situations of decreased force generation, *rapid recruitment*). When so defined, *decreased* recruitment values indicate a reduced pool of motor units, while *increased* values indicate an increased number of units firing relative to strength of contraction.

B.4.5.5 Numeric results may apply to a single site (which may be identified, if necessary, in the sample number portion of the test/observation ID) or may be a statistical measure (mean, minimum, maximum, standard deviation, etc.) derived from multiple sites.

B.4.5.6 *Single Fiber EMG Value Identifiers*—The value identifiers which may be used with CPT-4 code 95872 (single fiber EMG) and a waveform/activity identifier of 00 to identify particular characteristics of the single fiber discharges are given in Table B-14, along with the usual grading or coding system (described in B.9 and B.10) used for each coded entry result (CE).

B.4.5.7 The parameters listed in Table B-14 may be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10, or as actual numeric values and their units (estimated from visual inspection or determined by computer processing), or both. Examples of numeric results which may be given and their appropriate units are as follows:

B.4.5.8 *Jitter* refers to the variation in timing between pairs of single fiber discharges and may be calculated as a mean consecutive difference (units = us or ms). The *fraction of discharges with blocking* may be a unitless number or a percentage (units = %). *Number of discharges per site* represents the number of discharges which were sampled to calculate the jitter and the blocking parameters (codes 1 through 3). *Fiber density* refers to the number of single fiber potentials in a motor unit (unitless). *Duration* refers to the time from the first to last single fiber potential in a motor unit (units = us or ms). *Interspike interval* is calculated as the duration divided by the fiber density (units = us or ms).

B.4.5.9 Any of the numeric results in B.4.5.8 may apply to a single sample or site (which may be identified, if necessary, in the sample number portion of the test/observation ID code) or may be a statistical measure (mean, minimum, maximum, standard deviation, etc.) calculated from multiple sites. The *blocking* parameter, when it applies to a single site, specifies only the presence or absence of blocking at that site (as opposed to *fraction of discharges with blocking*), and can be specified either as numeric data (with a value of 0 meaning absent, 1 meaning present or recorded) or as a coded entry with similar meanings (**ABUN** coding system, codes 0 or 1). However, when used with statistical measure code 9902 (mean), this parameter specifies the fraction (unitless) or percent (units = %) of sites exhibiting some amount of blocking.

B.4.6 *Examples of Test/Observation ID Codes for EMG and Related Studies*—This scheme for classifying EMG and related tests does not imply that any or all of the combinations of the codes in B.4.1 through B.4.5.6 define values that are useful or need be reported for any given study in any laboratory. However, the scheme is general enough to cover the practices of most laboratories, and an alphabetic character for each type of identifier may be used to represent categories which are not otherwise representable in this scheme. Table B-16 presents some examples of test/observation ID codes for EMG and related studies.

B.5 *Test/Observation ID Codes for NCS and Related Studies*—The test/observation ID codes for nerve conduction studies (NCS) and related studies are constructed by adding extension codes defined in B.5.2 through B.5.12 to CPT-4 codes, to identify specific stimulus types and stimulating and recording sites and the specific nerves studied, a specific sample (trial) number (when needed), and individual quantitative or qualitative test results pertaining to the study. Complete codes of the form **959tt.ddddpnnnnwv** are used to fully identify an individual test result. Here, **tt** is a two character test identifier, **dddd** is a four character distal site (muscle or nerve) identifier, **p** is a one character proximal site identifier, **nnnn** is a four character trial number, **w** is a one character waveform identifier, and **v** is a one character value identifier. Less complete (less selective) codes of the form **959tt.ddddpnnnn** or **959tt.ddddp** are used to identify specific stimulus types and stimulating and recording sites and specific nerves studied (and specific trials, if needed). Unqualified CPT-4 codes of the form **959tt** refer to the entire study. For example, codes of the form **959tt** may specify the type of study to which one of the NCS and related study diagnostic codes (coding systems **MNCD**, **SNCD**, or **NMJD**) described in B.11.4 applied. When more than one type of NCS is performed simultaneously (for example, stimulating median nerve and recording simultaneously the motor response from the abductor pollicis brevis muscle and the antidromic sensory response from the proper digital palmar nerves), more than one test/observation ID code could be used to identify each type of NCS and each individual test result, even though separate stimulations were not performed; in contexts where only a single test/observation ID were allowed, it would be necessary to select the one most descriptive test/observation ID.

B.5.1 *CPT-4 Codes for NCS and Related Studies*—These five character codes (**959tt**) identify types of NCS and related studies. Table B-17 lists the applicable CPT-4 codes, along with the usual coding systems (described in B.11.4) used for diagnostic impressions related to these studies (Diagnosis). Code 95903 may be used for long loop reflex/silent period studies done in addition to F-wave studies. Code 95937 includes periodic paralysis studies. Also, code 9590X is a generic NCS test code which may be used to order motor, sensory, or special NCS chosen according to clinical indications and local norms.

B.5.2 *Motor NCS Recording Site Identifiers*—These four character codes (**dddd**) are used with CPT-4 codes 95900, 95903, 95934, 95936, and 95937 for motor NCS and related studies to identify the specific muscle recorded from and the type of stimuli (electric or magnetic) used to stimulate the motor nerve. The first character of the four character code identifies the type of stimuli employed, the side of stimulation, and the general location of the muscle recorded from. The codes in Table B-18 may be used for this first character.

B.5.2.1 The remaining three characters of the four character code are derived from the last three characters of the SNOMED topographic codes **T-13###** (muscles of head, neck, mouth, and upper extremity) and **T-14###** (muscles of trunk, perineum, and lower extremity). The particular motor nerve stimulated can be inferred from the muscle recorded from. The three characters 000 indicate an unspecified muscle. The diaphragm is coded by the three characters 400 with a preceding 0, 2, 4, or 6.

B.5.3 *Motor NCS Stimulation Site Identifiers*—These one character codes (**p**) are used with CPT-4 codes 95900, 95903, 95934, 95936, and 95937 for motor NCS and related studies to identify the specific stimulation site along the motor nerve. Codes 1 and 2 may be used for all nerves, while codes 3 to 9 are used to denote sites along nerves in the extremities, as listed in Table B-15. A typical CNS stimulation site would be the contralateral motor cortex (stimulated in surgery or transcranially). A typical stimulation site near the brachial plexus would be Erb's point (supraclavicular area); a typical stimulation site near the lumbar plexus or cauda equina would be over the lumbar spine. Proximal arm often refers to the axilla, and proximal thigh to the groin. Distal arm often refers to the elbow, distal thigh to the knee, distal forearm to the wrist, and distal leg to the ankle. The notations proximal, intermediate, and distal have different meanings for different nerves (for example, for common peroneal nerve/extensor digitorum brevis muscle NCS, the usual proximal leg site would be distal to the head of the fibula and the distal leg site would be at the ankle). For simplicity of implementation, the text associated with codes 4 to 9 applies to nerves in either the upper or lower extremity; if desired, a more complex implementation could be designed to select appropriate text for a stimulation site identifier based on whether it was used with a recording site identifier of an upper or lower extremity (for example, code 9 would mean *at distal forearm site* when used with the median nerve, but *at distal leg site* when applied to a common peroneal nerve recording).

B.5.4 *Motor NCS Trial Number*—This four character code (**nnnn**) identifies a particular trial in a motor NCS study with a given nerve and stimulation/recording sites, or specifies a type of statistical measure which was derived from multiple trials. For example, several stimulations could be performed; in conjunction with the value identifier character which follows, these four characters could identify the trial to which individual amplitude or latency values apply, or specify statistical measures (such as mean amplitude or latency) based on all trials. For neuromuscular junction or periodic paralysis testing, multiple stimuli are used; the results of each can be identified by the trial number. The codes described in Table B-1 are used.

B.5.5 *Motor NCS Waveform Identifiers*—These one character codes (**w**) identify particular waveforms or portions of the recorded responses to motor nerve stimulation. The meaning of these codes depends on the type of motor NCS, as identified by the CPT-4 code. When the waveform identifier is zero, the following character is interpreted as a stimulus characteristic identifier instead of a motor NCS value identifier, as described in B.5.12.

B.5.5.1 *Standard Motor NCS Waveform Identifiers*—The waveform identifiers which may be used with CPT-4 codes 95900 or 95903 (motor NCS) or codes 95934 or 95936 (H-reflex studies) to identify particular waveforms or portions of recorded responses are given in Table B-19. For H-reflex studies, CMAP (compound muscle action potential) refers to the M-wave, and codes 1 and 3 are used. For F-reflex studies, codes 1 and 2 are used. For long loop reflex/silent period studies, codes 4 and 5 are used.

B.5.5.2 *Neuromuscular Junction Testing Waveform Identifiers*—The waveform identifiers which may be used with CPT-4 code 95937 (neuromuscular junction or periodic paralysis testing) to identify particular types of recorded responses are given in Table B-20. Here, *slow rate* refers to a repetitive train of stimuli delivered at a rate of a few hertz, while *fast rate* refers to larger rates. The *with exercise* values refer to the results obtained during or immediately after a period of exercise (or tetanic stimulation), while *after exercise* values refer to results obtained a longer time after exercise. For periodic paralysis testing, only codes 1, 4, and 7 are used since trains of repetitive stimuli are usually not used.

B.5.6 *Motor NCS Value Identifiers*—These one character codes (**v**) identify particular characteristics of waveforms or portions of the recorded responses to motor nerve stimulation. An individual quantitative or qualitative NCS test result is identified by the combination of a one character waveform identifier and a one character value identifier, for example, *CMAP amplitude*. The value identifiers which may be used following a nonzero waveform identifier to identify a particular waveform characteristic are given in Table B-21.

B.5.6.1 The parameters in Table B-21 may be specified as coded entries (CE), when it is desired to grade the degree of abnormality by using the relative grading system for quantitative results (**RELA**) described in B.10.1, or as actual numeric values and their units, or both. Examples of numeric results which may be given and their appropriate units are as follows. *Amplitude* may refer to the peak-to-peak or baseline-to-peak amplitude of a waveform (units = mv or uv), as appropriate. *Area* refers to the total area under the waveform (units = mv.ms or uv.ms). *Motor unit number* (unitless), used only with a CMAP waveform identifier, represents an estimate of the number of motor units, obtained for example by dividing the maximum CMAP amplitude by the average increment in CMAP amplitude observed with small increases in the intensity of minimal stimuli. Latency may refer to the onset or peak latency of the waveform, as appropriate, from the time of the stimulus (units = ms). Duration refers to the time from onset to end of the waveform or the silent period (units = ms).

B.5.6.2 *Amplitude ratio* (unitless, or units = %), when used with the CMAP waveform identifier, represents the ratio of CMAP amplitude with the specified stimulation site to that with a more distal stimulation site, but when used with other waveform identifiers (such as F-wave or H-reflex), it may refer to the ratio of the specified waveform amplitude to the M-wave (CMAP) amplitude at one stimulation site; also, for neuromuscular junction or periodic paralysis testing, it may instead refer to the ratio of the amplitude of the CMAP under particular test conditions to the baseline or reference CMAP amplitude (for example, the amplitude of the response to the first stimulus in a train). *Area ratio* (unitless, or units = %) is similar but applies to area rather than amplitude measurements. *Ipsilateral to contralateral latency difference* may represent the absolute value of the difference between the latency of the waveform recorded when stimulating the specified nerve and its contralateral counterpart at a corresponding site (units = ms). *Ipsilateral reference nerve latency difference* may represent the difference between the latency of the waveform recorded when stimulating the specified nerve and another ipsilateral reference nerve at a corresponding site (units = ms); for example, the ulnar nerve may be the *reference* for the median nerve, and vice versa, so that ulnar-to-median latency differences are represented. For F-waves, ipsilateral reference nerve latency difference may alternatively represent the difference between the actual and the estimated (from measured distances) F-wave latency. *Conduction velocity*, used primarily with a CMAP waveform identifier, represents a propagation velocity between the specified site and a more distal site (units = m/s); it may be calculated from the latency difference between the CMAP recorded with the specified stimulation site and that recorded with a more distal stimulation site and the distance between sites, or from the CMAP latency and the distance from the stimulating to the recording site.

B.5.6.3 The specific meanings of results identified by any of these codes is laboratory and study dependent, and is reflected in the specific normal values associated with the numeric results. For example, the particular distal site chosen for amplitude or area comparisons and velocity calculation and the methods used to measure latency and calculate velocity may differ between laboratories and may vary depending on the study being performed.

B.5.6.4 Any of the numeric results in B.5.6.1 and B.5.6.2 may apply to a single sample or trial (which may be identified, if necessary, in the sample number portion of the test/observation ID code) or may be a statistical measure (mean, minimum, maximum, standard deviation, etc.) calculated from multiple samples (multiple trials). A single trial, for example, may be one response within a train of repetitive stimuli (for neuromuscular junction testing) or an individual response obtained over the course of a prolonged observation period (for periodic paralysis testing).

B.5.7 *Sensory NCS Distal Site Identifiers*—These four character codes (**dddd**) are used with CPT-4 codes 95904 and 95933 for sensory nerve conduction and blink reflex studies to identify the specific sensory nerve tested, including the specific distal branch stimulated (for orthodromic conductions on spinal or cranial nerves) or the specific distal branch recorded from (for antidromic conductions on spinal nerves) and the direction of conduction (orthodromic or antidromic) and type of stimulation (electric or magnetic) used. The first character of the four character code identifies the direction and type of stimuli employed, the side of stimulation, and whether a spinal or a cranial nerve was stimulated; the codes in Table B-22 are used.

B.5.7.1 The remaining three characters of the four character code are derived from the last three characters of the SNOMED topographic codes **T-X9###** (spinal nerves) and **T-X8###** (cranial nerves). The three characters 000 are used to represent an unspecified sensory nerve.

B.5.8 *Sensory NCS Proximal Site Identifiers*—These one character codes (**p**) are used with CPT-4 code 95904 for sensory nerve conduction studies to identify the specific proximal recording site (for orthodromic conduction) or the specific proximal stimulation site (for antidromic conduction) along the sensory nerve. The same proximal site identifiers given in Table B-15 for motor NCS are also used for sensory NCS (although CNS stimulation is usually not employed for sensory studies). Code 0 is used for blink reflex testing (CPT-4 code 95933) which uses a predetermined recording site. Code 0 may also be used for orthodromic sensory NCS using multiple simultaneous recording sites, since only one site can be identified in a single test/observation ID code; however, multiple separate test/observation ID codes can be used when necessary to identify the individual test results at multiple recording sites, even when the data for all of these sites were collected simultaneously during one stimulation. The exact site indicated by any of these codes depends on the particular nerve studied (for example, for sural nerve antidromic conductions, the proximal, intermediate, and distal leg sites could all be in the lower calf above the ankle at three equally spaced points along the nerve).

B.5.9 *Sensory NCS Trial Number*—This four character code (**nnnn**) identifies a particular trial in a sensory NCS or blink reflex study with a particular nerve and stimulation/recording sites, or specifies a statistical measure which was derived from multiple trials. For example, several stimulations could be performed; in conjunction with the value identifier character which follows, these four characters could identify the trial to which individual amplitude or latency values apply, or specify statistical measures (such as mean amplitude or latency) based on all trials. When *waveforms* resulting from several stimulations are averaged before amplitude and latency values are determined, the averaged waveforms represent only a *single* trial. The codes described in Table B-1 are used.

B.5.10 *Sensory NCS Waveform Identifiers*—The one character codes (**w**) in Table B-23 are used with CPT-4 code 95904 (sensory NCS) or code 95933 (blink reflex studies) to identify particular waveforms in recorded responses to sensory nerve stimulation. When the waveform identifier is zero, the following character is interpreted as a stimulus characteristic identifier instead of a sensory NCS value identifier, as described in B.5.12.

B.5.11 *Sensory NCS Value Identifiers*—These one character codes (**v**) identify particular characteristics of waveforms or portions of the recorded responses to sensory nerve stimulation. An individual quantitative or qualitative NCS test result is identified by the combination of a one character waveform identifier and a one character value identifier, for example *SNAP amplitude*. The value identifiers which may be used following a nonzero waveform identifier to identify a particular waveform characteristic are given in Table B-24.

B.5.11.1 The parameters in Table B-24 may be specified as coded entries (CE), when it is desired to grade the degree of abnormality by using the relative grading system for quantitative results (**RELA**) described in B.10.1, or as actual numeric values and their units, or both. Examples of numeric results which may be given and their appropriate units are as follows. *Amplitude* may refer to the peak-to-peak or baseline-to-peak amplitude of a waveform (units = uv), as appropriate. *Area* refers to the total area under the waveform (units = uv.ms). *Peak* and *onset latency* refers to the latency from the time of the stimulus (units = ms) to the peak or onset of the waveform. *Duration* refers to the time from onset to end of the waveform (units = ms). *Amplitude ratio* (unitless, or units = %), when used with the SNAP (sensory nerve action potential) waveform identifier, may represent the ratio of SNAP amplitude at the specified site to that at a more distal site. *Area ratio* (unitless, or units = %) is similar but applies to area rather than amplitude measurements. *Ipsilateral to contralateral latency difference*, for the SNAP and R1 waveform identifiers, may represent the absolute value of the difference between the latency of the waveform recorded from the specified nerve and its contralateral counterpart at a corresponding site (units = ms); when used with the R2 waveform identifier, it may instead represent the absolute value of the difference between the latency of the ipsilateral R2 peak and the contralateral R2 peak, both obtained when stimulating the same side. *Ipsilateral reference nerve latency difference*, for the SNAP waveform identifier, may represent the difference between the latency of the SNAP recorded from the specified nerve and another ipsilateral reference nerve at a corresponding site (units = ms); for example, the ulnar nerve may be the *reference* for the median nerve, giving ulnar-to-median latency differences. For the R2 waveform identifier, ipsilateral reference nerve latency difference may alternatively represent the R1 to R2 waveform latency difference. *Conduction velocity*, used primarily with the SNAP waveform identifier, represents a propagation velocity between the specified site and a more distal site (units = m/s); it may be calculated from the latency difference between the SNAP at the specified site and that at a more distal site and the distance between sites, or from the SNAP latency and the distance from stimulating to recording site.

B.5.11.2 The specific meanings of results identified by any of these codes is laboratory and study dependent, and is reflected in the specific normal values transmitted with the numeric results. Any of these numeric results may apply to a single trial (which may be identified, if necessary, in the sample number portion of the test/observation ID code) or may be a statistical measure (mean, minimum, maximum, standard deviation, etc.) derived from multiple trials.

B.5.12 *NCS Stimulus Characteristics Identifiers*—The NCS stimulus characteristics identifiers, which are used instead of a motor or sensory NCS value identifier when the preceding waveform identifier is zero to identify a particular stimulus characteristic used during performance of the NCS, are given in Table B-25, along with the usual grading system (described in B.10.2) used for each coded entry (CE) result.

B.5.12.1 The parameters listed in Table B-25 may all be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10.2, or as actual numeric values and their units, or both. Examples of numeric results that may be given for these parameters and their appropriate units are as follows.

B.5.12.2 *Stimulus rate* specifies the repetition rate of the stimulus (units = hz). *Stimulus duration* specifies the duration of each stimulus (units = us or ms). *Stimulus intensity* specifies the intensity (for example, voltage or current or magnetic field strength integral) of each stimulus (units = v, ma, or a.s/m = ampere-seconds per metre).

B.5.12.3 Any of these numeric results applies to a single sample or trial (which may be identified, if necessary, in the sample number portion of the test/observation ID code). Each trial may be performed with a different value of one or more of the stimulus parameters.

B.5.13 *Example Test/Observation ID Codes for NCS and Related Studies*—This scheme for classifying NCS and related tests does not imply that any or all of the combinations of the codes in B.5.1 through B.5.12 define values that are useful or need be reported for any given study in any laboratory. However, the scheme is general enough to cover the practices of most laboratories, and an alphabetic character for each type of identifier may be used to represent categories which are not otherwise representable in this scheme. Table B-26 has example test/observation ID codes for NCS and related studies.

B.6 *Test/Observation ID Codes for EP and Related Studies*—The test/observation ID codes for EP (evoked potentials) and EMF (evoked magnetic fields), ERP (event-related potentials), MRP (movement-related potentials), and related studies are constructed by adding extension codes defined in B.6.1 through B.6.13 to CPT-4 codes to identify the type of EP/EMF or ERP/MRP study, specific stimulation sites and conditions, a specific sample (trial) number (when needed), and individual quantitative or qualitative test results pertaining to the study. Complete codes of the form **9tttt.ksssnnnnpv** are used to fully identify an individual test result. Here, **tttt** is a four character test identifier, **k** is a one character identifier of the kind of EP study, **sss** is a three character stimulation site and condition identifier, **nnnn** is a four character trial number, **p** is a one character peak or harmonic identifier, and **v** is a one character value identifier. Less complete (less selective) codes of the form **9tttt.ksssnnnn** or **9tttt.ksss** are used to identify only the specific kind of study and the specific stimulation sites and conditions (and specific trials, if needed). Minimal codes of the form **9tttt.k** are used to refer to an entire study of the specified kind, or to specify the study to which an EP and related study diagnostic code (coding systems **SSED**, **ERGD**, **VEPD**, **DVED**, **ECOD**, **BAED**, **MAED**, **LAED**, **SEPD**, **MSED**, **PSED**, **TSED**, or **MRPD**) described in B.11.5 applies. Unqualified CPT-4 codes of the form **9tttt** are used to order generic classes of EP studies (electroretinogram, visual evoked potential, electrocochleogram, auditory evoked potential, or somatosensory evoked potential/movement-related potential) chosen according to the clinical indications and local norms. Code 9592X is a generic EP laboratory test code which can be used to order any class of evoked potentials chosen according to the clinical indications and local norms.

B.6.1 *Qualified CPT-4 Codes for EP and Related Studies*—These seven character codes (**9tttt.k**) identify basic kinds of EP or ERP/MRP studies; the same code may also be used for EMF studies, since the specific CPT-4 codes for these studies do not specify the modality tested and are therefore unsuitable as test/observation ID codes for EMF studies. Codes with **k** in the range from zero to four are used for transient EPs or ERPs; codes with **k** in the range from five to nine are used for steady-state EPs. For example, a common steady-state short-latency AEP is the frequency following AEP, and a common steady-state middle-latency AEP is the 40 Hz AEP. Table B-27 lists the applicable codes, along with the usual coding systems (described in B.11.5) used for diagnostic impressions for these studies (**Diagnosis**); note that CPT-4 codes 95925, 95926, and 95927 are used for MRPs as well as SEPs.

B.6.2 *VEP Stimulation Condition Identifiers*—For visual evoked potentials (VEP), electroretinograms (ERG), and ERPs related to visual stimuli (CPT-4 codes 92275 and 95930), three character stimulation condition identifiers (**sss**) are used, with the first character specifying a portion of the visual field, the second character specifying the pattern used (if any), and the third character specifying a stimulus type and specific eye stimulated.

B.6.2.1 *VEP Visual Field Identifiers*—These one character codes identify a visual field area to which stimuli are presented; the codes in Table B-28 are used.

B.6.2.2 *VEP Stimulus Pattern Identifiers*—These one character codes identify the type of stimulus pattern employed. Code 0 may be used for diffuse light VEPs; for other VEPs, the codes in Table B-29 may be used.

B.6.2.3 *VEP Stimulus Type and Side Identifiers*—These one character codes identify the type of stimulus employed (that is, its temporal characteristics) and the particular eye stimulated. The codes in Table B-30 may be used; codes 1 to 3 may be used for appearance and disappearance stimuli types (for example, for diffuse light VEPs) as well as reversal stimuli types (for patterns).

B.6.3 *AEP Stimulation Condition Identifiers*—For auditory evoked potentials (AEP), electrocochleograms (ECoG), and ERPs related to auditory stimuli (CPT-4 codes 92584 and 92585), three character stimulation condition identifiers (**sss**) are used, with the first character specifying the polarity of the stimuli, the second character specifying the type of auditory stimuli employed, and the third character specifying the particular ear stimulated.

B.6.3.1 *AEP Stimulus Polarity Identifiers*—These one character codes identify the stimulus polarity. In Table B-31, alternating polarity refers to recordings in which the response to sounds alternating in polarity are averaged together.

B.6.3.2 *AEP Stimulus Type Identifiers*—These one character codes identify the stimulus type (waveform) employed. In Table B-32, click refers to unfiltered clicks.

B.6.3.3 *AEP Stimulus Side Identifiers*—These one character codes identify the particular ear to which the auditory stimulus is delivered. The codes in Table B-33 may be used.

B.6.4 *SEP Stimulation Site and Type Identifiers*—For somatosensory evoked potentials (SEP) and ERPs related to somatosensory stimuli (qualified CPT-4 codes 95925.**k**, 95926.**k**, and 95927.**k** for **k** equal to 0, 1, or 5), three character stimulation type and site (sensory nerve or dermatome) identifiers (**sss**) are used, with the first character specifying the type of stimuli (electric or other) and the side of stimulation and whether a spinal or a cranial nerve was stimulated, and the second and third characters specifying the particular sensory nerve or dermatomal region stimulated.

B.6.4.1 *SEP Stimulus Type and Side Identifiers*—These one character codes identify the type of stimuli employed, the side of stimulation, and whether a spinal or a cranial nerve was stimulated. The codes in Table B-34 may be used; codes 3 to 5 may be used for magnetic or other nonelectric stimulation (for example, percussion, touch, or vibration).

B.6.4.2 *SEP Nerve Identifiers*—These two character codes identify the specific sensory nerve stimulated. The two characters that identify a specific nerve are derived from the hundreds and tens digits of the five character SNOMED topographic codes **T-X9###** (spinal nerves) or **T-X8###** (cranial nerves); the units digit is ignored. Table B-35 summarizes the codes used for the most commonly performed SEPs; note that cervical, thoracic, lumbar, and sacral nerves refer to stimulation in the specified dermatome; the two characters 00 are used to mean an unspecified nerve.

B.6.5 *MRP Site of Movement Identifiers*—For movement-related potentials (MRPs, which are ERPs related to motor events; qualified CPT-4 codes 95925.4, 95926.4, and 95927.4), three character site of movement identifiers (**sss**) are used, with the first character specifying the side and general location of the movement (upper or lower extremity, or head and neck), and the second and third characters specifying the specific location of the movement.

B.6.5.1 *MRP Movement Side and Region Identifiers*—These one character codes identify the side on which movement occurred, and whether the movement was in the upper extremity, lower extremity, or head and neck. The codes in Table B-36 may be used.

B.6.5.2 *MRP Movement Location Identifiers*—These two character codes specify the location of a movement. The two characters that identify the body part moved are derived from the hundreds and tens digits of the five character SNOMED topographic codes **T-Y8###** (upper extremity), **T-Y9###** (lower extremity), or **T-Y0###** (head/neck); the units digit is ignored. The two characters 00 indicate an unspecified body part.

B.6.6 *EP Trial Number*—This four character code (**nnnn**) identifies a particular trial in an EP or related study with a particular stimulation site and conditions, or specifies a type of statistical measure which was derived from multiple trials. Several EP recordings could be performed with different stimulus rate, duration, intensity, contrast or tone frequency, size of visual field, or size of pattern elements; in conjunction with the peak and value identifiers which follow, these four characters could identify the particular trial to which individual amplitude or latency values apply, or specify statistical measures (such as mean amplitude or latency) based on all of the trials. Abscissa and ordinate values for a latency-intensity curve could be associated in this fashion, for example. The averaged waveforms from one EP recording (using one set of stimuli) represent only a *single* trial in this context. The codes described in Table B-1 are used.

B.6.7 *Steady-state EP Harmonic Identifiers*—These one character codes (**p**), used for steady-state EP recordings (test/observation ID codes with first character after the period of 5 to 9), identify particular harmonics (or sets of harmonics) in the evoked response. The fundamental has a frequency equal to that of the stimulus, the second harmonic has a frequency twice that of the stimulus, etc. The codes given in Table B-37 are used.

B.6.8 *Transient VEP Peak Identifiers*—These one character codes (**p**), used for transient electroretinograms (ERGs, qualified CPT-4 code 92275.0) and transient VEPs and ERPs related to visual stimulation (qualified CPT-4 codes 95930.0, 95930.1, 95930.2, and 95930.3), identify particular peaks (or sets of peaks) in the evoked response. Some laboratories may name these peaks differently. Nomenclature varies for the negative and positive peaks of the transient ERG and VEP to diffuse light stimuli. For recording contralateral to a stimulated left or right half field, the polarities/timings of the peaks may differ (for example, P75 instead of N75, N105 instead of P100, P135 instead of N145). The codes in Table B-38 may be used.

B.6.9 *Transient AEP Peak Identifiers*—These one character codes (**p**), used for transient electrocochleograms (ECoGs, qualified CPT-4 code 92584.0) and transient AEPs and ERPs related to auditory stimuli (qualified CPT-4 codes 92585.0 for BAEPs, 92585.1 for MLAEPs, and 92585.2 or 92585.3 for LLAEPs or auditory ERPs), identify specific peaks in the evoked response. The codes in Table B-39 are used (*micro* means microphonic); some laboratories name these peaks differently; P300 and P3 are the same.

B.6.10 *Transient SEP Peak Identifiers*—These one character codes (**p**), used for transient SEPs and ERPs related to somatosensory stimulation (qualified CPT-4 codes 95925.**k**, 95926.**k**, and 95927.**k** for **k** equal to 0 or 1), identify particular peaks (or sets of peaks) in the evoked response. The SEP peak names depend on the nerve tested; those for commonly tested nerves (median or ulnar, peroneal, or tibial) are given in Table B-40, as well as generic names for other nerves.

B.6.10.1 In Table B-40, popliteal (*poplit*) peak refers to the peak of the sensory nerve action potential recorded from popliteal fossa. Lumbar (*lumb*) peak refers to the peak recorded from lumbar spine. Low and high thoracic (*thor*) peak refers to the peak recorded from the low thoracic spine and the high thoracic (or, in some laboratories, the cervical) spine, respectively. Some laboratories may name these SEP peaks differently. Nomenclature varies for the major peaks of the SEP from stimulation of other peripheral nerves, but the scheme in Table B-40 can be used as a guide for nonstandard SEP studies.

B.6.11 *MRP Peak Identifiers*—These one-character codes (**p**) used for MRPs (qualified CPT-4 codes 95925.4, 95926.4, and 95927.4) identify particular peaks (or sets of peaks) in movement-related potentials. The codes in Table B-41 may be used.

B.6.11.1 In Table B-41, the Bereitschafts-potential and negative slope latencies are measured at onset rather than peak since the Bereitschafts-potential/negative slope complex has a linear ramp configuration terminating in the N1 peak. Some laboratories may name these peaks differently or choose different peaks for measurement. The P1 peak is probably equivalent to the premotion positivity, and the P2 peak is probably equivalent to the Reafferente Potentiale.

B.6.12 *EP Value Identifiers*—These one character codes (**v**) identify particular characteristics of EP peaks or harmonics. An individual quantitative or qualitative EP test result is identified by the combination of a one character peak or harmonic and a one character characteristic, for example, *P100 peak latency*. However, when the value (characteristic) identifier is zero, the peak or harmonic identifier instead specifies a particular stimulus characteristic as described in B.6.13. The nonzero value identifiers which may be used following a peak or harmonic identifier to identify a particular peak or harmonic characteristic are given in Table B-42, along with the usual grading or coding system (described in B.9.6 and B.10.1) used for each coded entry (CE) result.

B.6.12.1 The parameters listed in Table B-42 other than *morphology* may be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10.1 or as actual numeric values and their units, or both. The *morphology* parameter can only be specified as a coded entry, using the appropriate coding system described in B.9.6. Morphology represents the shape of the specified peak. Examples of numeric results which may be given for the other parameters and their appropriate units are as follows.

B.6.12.2 *Latency* (for transient EPs or ERPs) represents the time from the stimulus or event to the peak or onset of the specified peak (units = ms). *Phase* (for steady-state EPs) represents the phase lag of the specified harmonic from the stimulus (units = deg or rad). *Amplitude* represents the peak-to-peak or zero-to-peak amplitude of the specified peak or harmonic (units = uv or mv). *Ipsilateral to contralateral latency difference* (for transient EPs or ERPs; units = ms) or *phase difference* (for steady-state EPs; units = deg or rad) represents the absolute value of the difference between the latency of the peak (or phase of the harmonic) recorded when stimulating the specified side and its contralateral counterpart. *Ipsilateral to contralateral amplitude ratio* (unitless) represents the ratio of the amplitudes of the peak or harmonic recorded when stimulating the specified side and its contralateral counterpart. These value identifiers (codes 1 to 6) are used following the peak/harmonic identifier codes which identify a *single* peak or harmonic.

B.6.12.3 *Latency difference* (for transient EPs or ERPs) or *phase difference* (for steady-state EPs) represents the difference (second minus first) between the latencies of the two specified peaks (units = ms) or the difference between the phases of the two specified harmonics (units = deg or rad). *Amplitude ratio* (unitless) represents the ratio (second divided by first) of the amplitudes of the two specified peaks or harmonics. These value identifiers (codes 7 to 9) are used following the peak/harmonic identifier codes which identify *two* peaks or harmonics.

B.6.12.4 Any of the numeric results in B.6.12.2 and B.6.12.3 may apply to a single sample or trial (which may be identified, if necessary, in the sample number portion of the test/observation ID code) or may be a statistical measure (mean, minimum, maximum, standard deviation, etc.) calculated from multiple samples (multiple trials).

B.6.13 *EP Stimulus Characteristics Identifiers*—The stimulus characteristics identifiers which are used instead of a peak/harmonic identifier when the subsequent value identifier character is zero to identify a particular stimulus characteristic used during performance of the EP/EMF or ERP/MRP are given in Table B-43, along with the usual grading system (described in B.10.2 and B.10.3) used for each coded entry (CE) result.

B.6.13.1 The parameters listed in Table B-43 may all be specified as coded entries (CE), when it is desired to grade them by using the appropriate grading system described in B.10.2 and B.10.3, or as actual numeric values and their units, or both. Examples of numeric results which may be given for these parameters and their appropriate units are as follows.

B.6.13.2 *Stimulus rate* specifies the repetition rate of the stimulus (units = hz); for pattern reversal or appearance/disappearance stimuli, this is the number of complete cycles (white to black to white) per unit time. *Stimulus duration* specifies the duration of each stimulus (units = us, ms, or s); for extended stimuli such as pattern reversal, this is one half the cycle period (the duration of each state of a pattern element). Stimulus intensity specifies the intensity (for example, luminance, sound intensity, voltage, or current) of each stimulus; units = cd/m2, cd/cm2, cd.s/m2, db, db(sl), db(hl), db(nhl), db(spl), db(pespl), v, or ma. *Stimulus abundance* (used for mixed stimulus paradigms employing a common stimulus type and one or more less common or *oddball* stimuli types, the evoked responses from which are separately averaged and analyzed, for example, auditory tones with two or more different tone frequencies) specifies the fraction (unitless) or percentage (units = %) represented by this particular stimulus among all the stimuli presented. *Auditory stimulus frequency* specifies the frequency of the tone (units = hz). *Visual stimulus color* specifies the color of the light used as a nine character coded integer of the form **rrrgggbbb**, where **rrr** (000-255) is the relative amount of red light, **ggg** is the relative amount of green light, and **bbb** is the relative amount of blue light in the stimulus. Color may alternatively be specified qualitatively as a coded entry using coding system **COLO**. *Visual stimulus contrast* specifies the contrast of the visual pattern (unitless), defined as $(L_{max} - L_{min})/(L_{max} + L_{min})$, where L_{max} is the luminance of the brightest elements of the pattern and L_{min} is the luminance of the darkest elements. *Visual pattern element size* specifies the size or spatial period (inverse of spatial frequency) of the pattern elements (angle subtended by each at actual viewing distance; units = deg or rad). *Visual field size* specifies the size of the visual field stimulated (angle subtended by the entire pattern at viewing distance; units = deg or rad).

B.6.13.3 Any of the numeric results stated in B.6.13.2 applies to a single sample or trial (which is an average of many individual evoked responses, and which may be identified, if necessary, in the sample number portion of the test/observation ID code). Each trial may be performed with a different value of one or more of the stimulus parameters, or may represent the average of the responses to a different stimulus type in a mixed stimulus paradigm.

B.6.14 *Examples of Test/Observation ID Codes for EPs and Related Studies*—This scheme for classifying

EPs and related tests does not imply that any or all of the combinations of the codes in B.6.1 through B.6.13 define values that are useful or need be reported for any given study in any laboratory. However, the scheme is general enough to cover the practices of most laboratories, and an alphabetic character for each type of identifier may be used to represent categories which are not otherwise representable in this scheme. Table B-45 presents some examples of test/observation ID codes for EP and related studies.

B.7 *Test/Observation ID Codes for Body Temperature Measurements*—The test/observation ID codes for body temperature measurements are identical to those defined in NCCLS LIS 5-A. They are constructed by adding a one- character extension code to the root code **1000** (which is not a CPT-4 code, but a constructed **AS4** code for a test for which no CPT-4 code exists). Complete codes thus have the form **1000.t** where **t** is a one-character temperature identifier. These test/observation ID codes may be used when temperature measurements are made as part of any of the electroneurophysiologic studies. Temperature measurements are most commonly made as part of NCS and some EMG and EP studies, but may be of relevance to some EEG and related studies as well (for example, recordings for determining cerebral death). The codes listed in Table B-44 may be used. For each result that may be specified as a coded entry (CE), this table also lists the usual grading or coding system for each body temperature measurement.

B.7.1 The parameters listed in Table B-44 other than *temperature method* and *other temperature source* may all be specified as coded entries (CE) when it is desired to grade them by using the appropriate grading system described in B.10, or as actual numeric values and their units, or both. The *temperature method* parameter, which specifies the type of instrument used for the temperature measurement, can only be specified as a coded entry, using the **TMPM** coding system described in B.9.8. The *other temperature source* parameter, which specifies the body location for temperature measurements specified by code 1000.5 (*other temperature*), also can only be specified as a coded entry, using SNOMED topographic location codes with qualifiers (Appendix X1). Examples would include **T-51000** (mouth), **T-Y8100** (axilla), **T-68000** (rectum), **T-14980-N1** (number 1 interosseous dorsales muscles), and **T-Y9700-LFT** (left foot). *Oral temperature*, *rectal temperature*, *axillary temperature*, and *other temperature* represent temperature measurements at the corresponding body locations (units = cel unless otherwise specified).

Universal Codes for Test Results and Anatomic Localizations

B.8 The test result (including anatomic localization) codes described in B.9 may be used to specify a specific qualitative result which may be associated with one of the test/observation ID codes described in B.2 through B.7. This includes distributions (anatomic localizations), heart rhythms, sleep/wake stages, waveform characteristics, firing patterns, morphologies, colors, and temperature methods. Test result codes (see B.10) may also be used to grade quantitative results associated with a particular test/observation ID code, either on an absolute scale or relative to the normal or expected values for the laboratory. Most of the test result codes are single characters; the heart rhythm codes are two characters, and the distribution (anatomic localization) codes are four characters. Each of the classes of test result codes has a specific code table identifier which is specified as follows.

B.9 *Test Result Codes for Qualitative Results*—The classes of test result codes described in B.9.1 through B.9.8 are used to represent qualitative results of electroneurophysiologic studies.

B.9.1 *Distribution or Anatomic Localization (DIST) Codes*—These four character codes (specific code table identifier **DIST**) are used to specify the distribution (anatomic site or localization) on the head of waveforms or activities seen in some electrophysiologic studies, particularly EEG/MEG, PSG, and EP studies employing cephalic electrodes. They may be used to specify results for EEG and related studies test/observation ID codes having a value identifier of 9 (distribution). They may also be used to specify anatomic localizations associated with EEG, EP, and related study diagnostic impressions. Other universal coding systems such as SNOMED topographic location codes may alternatively be used for these purposes when desired, and for specifying anatomic localizations for EMG, NCS, and related studies. These codes are more suited to briefly characterize the distribution of EEG waveforms and activities, however. Generalized and regional waveform/activity distributions may be represented by use of a single code in the range from 0000-0999 chosen from Table B-48. Table B-48 also includes codes to represent single electrodes, which may be used when a waveform/activity (or a parameter derived from waveform analysis) applies to a single electrode location.

B.9.1.1 Alternatively, codes representing focal waveforms or activities may be constructed by summing one code from the first group in Table B-46 and one or more codes (as many as apply) from the second group. The corresponding text description for the resulting code is constructed by concatenating the individual text descriptions, using *and* to link the different descriptions from the second group. Table B-47 presents some examples of distributions (anatomic localizations) for EEG and EP studies.

B.9.2 *Heart Rhythm (RTHM) Codes*—These two character codes (specific code table identifier **RTHM**) are used to specify specific cardiac rhythms identified in channels used to record the EKG in an EEG or related study (test/observation ID code special parameter identifier 96, heart rhythm). The codes given in Table B-49 are used.

B.9.3 *Sleep and Wake Stage (STAG) Codes*—These one character codes (specific code table identifier **STAG**) are used to specify a wake/sleep stage assigned to a particular portion or epoch of an EEG or related study (test/observation ID code special parameter identifier 01, sleep stage). In Table B-50, *unstageable* is used when the epoch is too contaminated with movement or other artifacts to be reliably staged; *REM-spindle* sleep refers to epochs with mixed features of REM and stage II (spindle) sleep; and *alpha-delta sleep* refers to stage III or IV sleep in which alpha and delta activity coexist.

B.9.4 *Waveform Characteristics (WAVE) Codes*—These one character codes (specific code table identifier **WAVE**) specify additional characteristics of waveforms or activity seen in an EEG or related study (test/observation ID code value identifier 8, waveform characteristics). *Dipolar* refers to waveforms which have different polarities in different head regions (for example, a tangential dipole). *Subclinical discharge with repetitive* may prefix descriptions of waveforms or activity (such as sharp waves) that have an ictal appearance but are not considered to be seizures. *Subclinical seizure discharge with repetitive* may prefix descriptions of waveforms in an electrographic (larval) seizure. *Clinical seizure discharge with repetitive* may prefix descriptions of waveforms during a clinical seizure. The codes in Table B-51 are used.

B.9.5 *Firing Pattern (PATT) Codes*—These one character codes (specific code table identifier **PATT**) are used to specify the firing pattern of waveforms or activity seen in an EMG study (test/observation ID code standard EMG value identifier 9, firing pattern). In Table B-52, *regular* refers to activity firing at a constant rate, *irregular* to activity whose firing rate keeps changing, *stable* to activity which maintains the same firing pattern over a long period of time, and *unstable* to activity which does not.

B.9.6 *Peak Morphology (MRPH) Codes*—These one character codes (specific code table identifier **MRPH**) are used to specify morphology of peaks in EP and related studies. In Table B-53, *fused* means that the peak cannot be separated from the next peak, *W or M shape* means that it appears to be double, and *asymmetric* means that it has a skewed appearance.

B.9.7 *Visual Stimulus Color (COLO) Codes*—The one character codes in Table B-54 (specific code table identifier **COLO**) specify the color used for a visual stimulus.

B.9.8 *Temperature Method (TMPM) Codes*—The one character codes in Table B-55 (specific code table identifier **TMPM**) specify the type of instrument or method used for a body temperature measurement.

B.10 *Test Result Codes for Quantitative Results*—The classes of test result codes described in B.10.1 through B.10.5 are used to grade quantitative results of electroneurophysiologic studies; they may be used in addition to or instead of specifying an actual numeric value.

B.10.1 *Relative Grading System (RELA) for Quantitative Results*—These one character codes (specific code table identifier **RELA**) specify the degree and direction of abnormality of numeric values in comparison to normal values for the laboratory. This corresponds to a 4- (- - - -) to 4+ (++++) grading system. The text description for the codes given in Table B-56 is prefixed to that of the value to which they apply to give a complete text description (for example, *increased complexity*).

B.10.2 *Absolute/Relative Grading Systems for Quantitative Results*—These one character codes (specific code table identifiers **LOHI**, **SHLO**, and **SMLG**) are used to characterize a numeric value either on a three-grade absolute scale (no reference to normal values) or on a three-grade scale relative to normal values for the laboratory, as needed. The relative grades correspond to the 3- (- - -) to 3+ (+++) grading system used by some laboratories. The text description associated with these codes may be prefixed to the text description of the value to which they apply to give a complete text description of the value (for example, *low amplitude*). The three code tables available (**LOHI**, **SHLO**, and **SMLG**) differ only in the text descriptions associated with the absolute grades; **LOHI** (low-moderate-high) codes are applicable to amplitudes, frequencies, and similar values; **SHLO** (short-medium-long) codes are applicable to durations, latencies, and similar values; and **SMLG** (small-medium-large) codes are applicable to complexities, variabilities, and similar values. The codes given in Table B-57 are used.

B.10.2.1 As an example, amplitudes of abnormal waveforms seen in EEG and related studies may be classified as *low* if under 30 μV, *moderate* if in range 30-60 μV, and *high* if over 60 μV. Amplitudes of normal background activity might be graded differently, for example *low* if under 10 μV, *moderate* if in range from 10 to 60 μV, and *high* if over 60 μV.

B.10.3 *Grading System for Abundance (ABUN)*—These one character codes (specific code table identifier **ABUN**) are used to characterize the abundance of waveforms, activities, events, or stimuli on an absolute scale. *Recorded* is a generic code which indicates that the activity was seen during the test but does not otherwise specify its abundance. *Absent* corresponds to an abundance of 0%, *continuous* to an abundance of 100%. The codes given in Table B-58 are used.

B.10.4 *Grading System for Asymmetry (ASYM)*—The one character codes in Table B-59 (specific code table identifier **ASYM**) specify the asymmetry of waveforms in an EEG or related study (test/observation ID value identifier 5, asymmetry). The direction of asymmetry (decreased or increased) refers to the region identified by the distribution parameter; the degree is mild (<25%), moderate (25 to 50%), marked (50 to 75%), or very marked (75 to 100%).

B.10.5 *Grading System for Reactivity (REAC)*—These one character codes (specific code table identifier **REAC**) are used to characterize the reactivity of activities or events seen in an EEG or related study (test/observation ID value identifier 6, reactivity). *Paradoxically reactive* means that the amplitude of the activity changed oppositely to what was expected in response to the stimulus. The codes given in Table B-60 are used.

Universal Codes for Diagnostic Impressions

B.11 The diagnostic impression codes described in B.11.1 through B.11.5 may be used to convey the salient features of the electroneurophysiologic study by summarizing the type, direction, and degree of abnormality of the various quantitative study results and the type of abnormality of the various qualitative study results. Any number of codes can be applied to a given study or to any portion of a study to fully characterize its major features. For example, portions of an EEG study may include a sleep recording, a recording during photic stimulation, hyperventilation, or other activation technique. The test/observation ID codes described in B.2 through B.7 can identify the portion of a study to which the diagnostic impressions apply. Also, one or more diagnostic impressions can be associated with a particular anatomic localization identified by one of the distribution or localization codes described in B.9.1. The diagnostic impression codes described herein are probably most useful for EEG and EP studies, since diagnostic classifications for these tend to be closely related to observations and are less often related to clinical interpretations and clinical diagnoses than are the diagnostic classifications of EMG, NCS, and related studies. However, for all types of electroneurophysiologic studies, it may be useful to summarize the key features of the study for computerized databases and similar applications by use of the codes described herein, in addition to summarizing the clinical implications of the study by use of clinically oriented diagnostic coding systems such as ICD-9-CM or local coding systems developed by the laboratory.

B.11.1 *Special Diagnostic Codes For All Electroneurophysiologic Study Types*—The special one character codes given in Table B-61 are included in all of the specific code tables for diagnoses and may be used to express certain frequently encountered diagnoses for any type of electroneurophysiologic study. In Table B-61, *technically difficult* indicates that the study or portion thereof was interpretable but had technical difficulties; it may be used in conjunction with other diagnoses. *Technically unsatisfactory* indicates that the study or portion thereof had such severe technical difficulties that no other diagnosis can be reached. *No change* may be used for a portion of a study during which a clinical *spell* occurred, to indicate that no change was seen in the recording. *No activation* may be applied to a portion of a study such as a sleep recording when no new abnormal phenomena are seen.

B.11.2 *Diagnostic Coding System for EEG and Related Studies (EEGD)*—These four or more character codes (specific code table identifier **EEGD**) are constructed by prefixing one or more two character modifiers (as many as are required) to a two character EEG waveform/activity identifier. In many cases, only a single modifier is required, giving a four character code; sometimes, two or more are needed, giving six, eight, or more character codes.

B.11.2.1 Each two character modifier describes one characteristic of the specified waveform, activity, or event, such as its abundance, amplitude, frequency (for sinusoidal waveforms) or repetition rate (for periodic nonsinusoidal waveforms or events), duration, asymmetry (difference in amplitude between left and right sides), reactivity to stimuli or state changes, latency (from the start of the recording or portion thereof, such as sleep), and waveform characteristics (such as synchrony and polarity). The EEG waveform/activity identifiers to which the modifiers apply are those described in Table B-7 as part of the test/observation ID codes for EEG and related studies. The two character modifiers consist of a one character test result code and a one character value identifier. EEG value identifiers described in Table B-6 are used (except for *distribution*, which is not specified as part of the diagnostic code, although a distribution or anatomic localization may be associated with one or more diagnostic codes). The test result codes described in B.9 and B.10 (coding systems **ABUN**, **LOHI**, **SHLO**, **ASYM**, **REAC**, **WAVE**) are used.

B.11.2.2 A separate diagnostic code must be used to describe each waveform or activity of diagnostic significance. The text description for the diagnostic code is constructed by prefixing the descriptions for each of the modifiers (including the value identifier text such as *amplitude* or *frequency* when needed) to the description of the waveform or activity. Table B-62 gives examples of diagnostic codes for EEG and related studies.

B.11.3 *Diagnostic Coding System for EMG and Related Studies (EMGD)*—These four or more character codes (specific code table identifier **EMGD**) are constructed by prefixing one or more two character modifiers (as many as are required) to a two character EMG waveform/activity identifier (for standard EMG studies) or to the string *00* (for single fiber EMG studies). In many cases, only a single modifier is required, giving a four character code; sometimes, two or more modifiers may be needed, giving six, eight, or more character codes.

B.11.3.1 For standard EMG studies, each two character modifier describes one characteristic of the specified waveform or activity of diagnostic significance, such as its abundance or activation, amplitude, area, frequency or recruitment, duration, complexity (number of phases or turns), variability, rise time, and firing pattern (such as regularity and stability). The EMG waveform/activity identifiers to which the modifiers apply are those described in Table B-12 as part of the test/observation ID codes for EMG studies. The two character modifiers consist of a one character test result code and a one character value identifier. Standard EMG value identifiers described in Table B-13 are used. The test result codes described in B.9 and B.10 (coding system **RELA** for characteristics of potentials under voluntary control and insertional activity abundance, **LOHI** for other waveforms amplitude, area, or frequency, **SHLO** for other waveforms duration or rise time, **SMLG** for other waveforms complexity or variability, **ABUN** for other waveforms abundance, and **PATT** for firing pattern) are used.

B.11.3.2 A separate diagnostic code must be used to describe each waveform or activity of diagnostic significance. The corresponding text description for the diagnostic code is constructed by prefixing the concatenated text descriptions for each of the modifiers (including the value identifier text *activation* or *abundance, amplitude, area, frequency* or *recruitment, duration, complexity, variability*, or *rise time* when coding systems **RELA**, **LOHI**, **SHLO**, or **SMLG** are employed) to the text description of the waveform or activity.

B.11.3.3 For single fiber EMG studies, each two character modifier describes one characteristic of the single fiber discharges of diagnostic significance, such as jitter, fraction of discharges with blocking, blocking present, fiber density, duration, and interspike interval. The two character modifiers consist of a one character test result code and a one character value identifier. Single fiber EMG value identifiers described in B.4.5.6 (except for *number of discharges per site*) are used. The test result codes described in B.10.1 and B.10.3 (coding system **RELA** for jitter, fraction of discharges with blocking, fiber density, duration, and interspike interval, and **ABUN** for blocking) are used. The corresponding text descriptions for each of the modifiers (including the value identifier text *jitter, fraction of discharges with blocking, blocking, fiber density, duration*, and *interspike interval*) are concatenated to construct the complete text description for the diagnostic code. Table B-63 presents some examples of diagnostic codes for EMG and related studies.

B.11.4 *Diagnostic Coding Systems for NCS and Related Studies*—These three character codes (specific code table identifiers **MNCD** for motor NCS, **NMJD** for neuromuscular junction/periodic paralysis studies, or **SNCD** for sensory NCS) specify the degree and direction of abnormality of one of the result values for the NCS or related study. The codes consist of a one character test result code, a one character waveform identifier, and a one character value identifier. The standard NCS and related study waveform (Tables B-19, B-20, and B-23) and value identifiers (Tables B-21 and B-24) are used in conjunction with the test result codes described in Table B-56 (coding system **RELA**). The corresponding text description for the diagnostic code is constructed by concatenating the text description for the result code to the text descriptions of the waveform and value identifiers (for example, *decreased CMAP amplitude*). Table B-64 gives examples of diagnostic codes for NCS and related studies.

B.11.5 *Diagnostic Coding Systems for EP and Related Studies*—These three character codes (specific code table identifiers **SSED** for all steady-state EPs, **ERGD** for ERGs, **VEPD** for pattern VEPs, **DVED** for diffuse light VEPs, **ECOD** for ECoGs, **BAED** for BAEPs, **MAED** for MLAEPs, **LAED** for LLAEPs, **SEPD** for generic SEPs, **MSED** for median/ulnar SEPs, **PSED** for peroneal SEPs, **TSED** for tibial SEPs, and **MRPD** for MRPs) specify the degree and direction of abnormality of one of the result values of the EP. The codes consist of a one character test result code, a one character peak or harmonic identifier, and a one character value identifier. The EP peak/harmonic (Tables B-37 through B-41) and value identifiers (Table B-42) and test result codes described in B.9 and B.10 (coding systems **RELA** or **MRPH**) are used. The text description for the diagnostic code is constructed by concatenating the text for the result code, peak/harmonic, and value identifiers (for example, *increased N9 peak latency*). Table B-65 gives example EP diagnostic codes.

TABLE B-1 Sample Number and Statistical Measure Codes

Code	Description
0000	[Unspecified]
####	Sample number ####
9901	Number of samples
9902	Mean
9903	Standard deviation of
9904	Minimum
9905	Maximum
9906	Lower bound of
9907	Upper bound of
9908	Fraction of samples with abnormal
9909-9999	[Reserved]

TABLE B-2 CPT-4 Codes for EEG and Related Studies

Code	Description	Code	Description
9580X	Sleep studies	95827	All night sleep EEG recording
95805	Multiple sleep latency test	95828	[Obsolete][D]
95807	Sleep recording without staging	95829	Electrocorticogram recording at surgery
95808	Polysomnogram, recording 1-3 sleep parameters	95950	24-h 8-channel EEG monitoring
95810	Polysomnogram, recording 4 or more sleep parameters	95951	24-h combined EEG/video monitoring
9581X	EEG studies	95952	[Obsolete][C]
95812	EEG extended monitoring 41-60 min	95953	24-h 16-channel (or more) portable EEG monitoring
95813	EEG extended monitoring greater than 1-h	95954	EEG recording with pharmacologic/physical activation
95816	EEG recording	95955	EEG recording during nonintracranial surgery
95817	[Obsolete][A]	95956	24-h 16-channel (or more) EEG monitoring by telemetry
95819	Awake and sleep EEG recording	95958	EEG recording during Wada test
95821	[Obsolete][A]	95961	Initial hour EEG monitoring during cortical stimulation
95822	Sleep or coma EEG recording	95962	Additional hour EEG monitoring during cortical stimulation
95823	[Obsolete][B]	95965	MEG recording
95824	EEG recording for cerebral death evaluation	95999	Surface EMG recording
95826	[Obsolete][C]		

[A]This code has been deleted in the current CPT-4; while it should still be accepted by receiver systems that conform to this specification, it may be treated as equivalent to code 95816 or 95819, and transmitter systems are encouraged to use the latter codes instead.

[B]This code has been deleted in the current CPT-4; while it should still be accepted by receiver systems that conform to this Technical Standard, it may be treated as equivalent to code 95954, and transmitter systems are encouraged to use the latter code instead.

[C]This code has been deleted in the current CPT-4; while it should still be accepted by receiver systems that conform to this Technical Standard, it may be treated as equivalent to 95829, 95950, 95951, 95953, or 95956, and transmitter systems are encouraged to use the latter codes instead.

[D]This code has been deleted in the current CPT-4; while it should still be accepted by receiver systems that conform to this Technical Standard, it may be treated as equivalent to code 95807, 95808, or 95810, and transmitter systems are encouraged to use the latter codes instead.

TABLE B-3 EEG Section of Recording Identifiers

Code	Description
00	[Unspecified]
01	With standard conditions
02	Before surgical resection
03	During surgical resection
04	After surgical resection
05	Before artery clamping
06	During artery clamping
07	After artery clamping
08	After sleep deprivation
09	[Reserved]
10	During administration of unspecified medication
11	During administration of sedative/hypnotic
12	During administration of anticonvulsant
13	During administration of convulsant
14	During administration of neuro-muscular blocking agent
15	During administration of barbiturate anesthetic
16	During administration of narcotic anesthetic
17	During administration of gaseous anesthetic
18-19	[Reserved]
20	During unspecified respiratory procedure
21	During hyperventilation
22	During continuous positive airway pressure
23	During mechanical ventilation
24-29	[Reserved]
30	During unspecified visual stimulation
31	During photic stimulation
32	While looking at pattern
33	While looking at picture
34	While reading
35	While viewing TV or CRT screen
36-38	[Reserved]
39	With room lights off
40	During unspecified auditory stimulation
41	While listening to music
42	While listening to speech
43	While listening to pure tones
44-49	[Reserved]
50	During unspecified somatosensory stimulation
51	During percussion stimulation
52	During passive joint movement
53	During active joint movement
54	During involuntary movement
55	During electrical stimulation
56	During painful stimulation
57-59	[Reserved]
60	During unspecified mental stimulation
61	While performing mental arithmetic
62	While answering questions
63	While counting
64-69	[Reserved]
70	During unspecified stimulation
71	During olfactory stimulation
72	During gustatory stimulation
73-79	[Reserved]
80	During unspecified special testing
81	During response testing
82	During startle testing
83	During alerting procedure
84	While standing
85	While walking
86-89	[Reserved]
90	During unspecified calibration procedure
91	During square wave calibration
92	During sine wave calibration
93	During biocalibration
94-99	[Reserved]

TABLE B-4 EEG State of Consciousness/Eye Closure Identifiers

Code	Description
00	[Unspecified]
01	While awake with eyes closed
02	While drowsy with eyes closed
03	While asleep with eyes closed
04	While lethargic with eyes closed
05	While obtunded with eyes closed
06	While stuporous with eyes closed
07	While comatose with eyes closed
08	While under general anesthesia with eyes closed
09	[Reserved]
10	During unspecified aura with eyes closed
11	During somatosensory aura with eyes closed
12	During visual aura with eyes closed
13	During olfactory/gustatory aura with eyes closed
14	During vertiginous aura with eyes closed
15	During abdominal aura with eyes closed
16	During autonomic aura with eyes closed
17	During psychic aura with eyes closed
18-19	[Reserved]
20	During unspecified partial seizure with eyes closed
21	During unspecified focal motor seizure with eyes closed
22	During focal myoclonic seizure with eyes closed
23	During focal clonic seizure with eyes closed
24	During focal tonic seizure with eyes closed
25	During focal atonic seizure with eyes closed
26	During complex partial seizure without automatisms, eyes closed
27	During complex partial seizure with automatisms, eyes closed
28	[Reserved]
29	During partial seizure with secondary generalization, eyes closed
30	During unspecified generalized seizure with eyes closed
31	During unspecified generalized motor seizure with eyes closed
32	During generalized myoclonic seizure with eyes closed
33	During generalized clonic seizure with eyes closed
34	During generalized tonic seizure with eyes closed
35	During generalized atonic seizure with eyes closed
36	During generalized tonic-clonic seizure with eyes closed
37	During absence seizure with eyes closed
38	During atypical absence seizure with eyes closed
39	[Reserved]
40	During unspecified clinical event with eyes closed
41	During unobserved epileptic seizure with eyes closed
42	During unspecified epileptic seizure with eyes closed
43	During nonpsychogenic nonepileptic event with eyes closed
44	During psychogenic nonepileptic event with eyes closed
45-49	[Reserved]

TABLE B-5 EEG Special Parameter Identifiers

Code	CE	Description
Sleep Parameter Identifiers		
00	...	[Unspecified]
01	STAG	Sleep stage
02-89	...	[Reserved]
Respiratory and Cardiovascular Parameter Identifiers		
90	LOHI	Unspecified cardiorespiratory parameter
91	LOHI	Respiratory air flow
92	LOHI	Ventilatory effort
93	LOHI	Oxygen saturation
94	LOHI	Atrial heart rate
95	LOHI	Ventricular heart rate
96	RTHM	Heart rhythm
97	LOHI	Systolic blood pressure
98	LOHI	Diastolic blood pressure
99	LOHI	Intracranial pressure

TABLE B-6 EEG Value Identifiers

Code	CE	Description
1	ABUN	Abundance
2	LOHI	Amplitude
3	LOHI	Frequency
4	SHLO	Duration
5	ASYM	Asymmetry
6	REAC	Reactivity
7	SHLO	Latency
8	WAVE	Waveform characteristics
9	DIST	Distribution

TABLE B-7 EEG Waveform/Activity Identifiers

Code	Description
00	Recording
Sleep and Wake Stage	
01	Unstageable activity
02	Stage W (wake) activity
03	REM sleep activity
04	REM-spindle sleep activity
05	Stage I sleep activity
06	Stage II sleep activity
07	Stage III sleep activity
08	Stage IV sleep activity
09	Alpha-delta sleep activity
Background and Slow Wave Activity[A]	
10	Background activity
11	Beta activity
12	Alpha activity
13	Mu activity
14	Theta activity
15	Bisynchronous theta activity
16	Delta activity
17	Bisynchronous delta activity
18	Arrhythmic delta activity
19	Slow fused transients
1A	Intermittent rhythmic delta activity
Sleep Activity and Events[B]	
20	Sleep activity
21	Sleep spindles
22	V waves
23	F waves
24	K complexes
25	Positive occipital sharp transients of sleep (POSTS)
26	Saw tooth waves
27	Sleep stage shifts
28	Arousals
29	Awakenings
Sharp Appearing or Epileptiform Activity[C]	
30	Unspecified epileptiform discharges
31	Sharp transients
32	Wickets
33	Small sharp spikes
34	Zeta waves
35	Triphasic waves
36	Phantom spike and wave activity
37	14 and 6 Hz positive bursts
38	Lambda waves
39	Rhythmic theta of drowsiness
3A	Subclinical rhythmic electrographic discharge of adults
Epileptic/Potentially Epileptogenic Activity[D]	
40	Unspecified ictal discharges
41	Sharp waves
42	Spikes
43	Multiple spikes
44	Spike and wave complexes
45	Multiple spike and wave complexes
46	Atypical spike and wave complexes
47	Sharp and slow wave complexes
48	Rhythmic sharp waves
49	Multiple independent spikes and asynchronous slow (hypsarrhythmia)
Periodic/Quasiperiodic Cerebral Activity[E]	
50	Unspecified periodic cerebral activity
51	Quasiperiodic triphasic waves
52	Periodic triphasic waves
53	Periodic epileptiform discharges
54	Periodic complexes
55	Quasiperiodic sharp waves
56	Periodic sharp waves
57	Periodic suppressions
58	Periodic bursts with suppression
59	[Reserved]
Eye-related Activity[F]	
60	Unspecified eye movements
61	Eye blinks
62	Nystagmoid eye movements
63	Slow eye movements
64	Fast irregular eye movements
65	Rapid eye movements
66	Photic driving activity
67	Photomyogenic activity
68	Photoparoxysmal activity
69	Electroretinogram
Myogenic Noncerebral Activity[G]	
70	Unspecified myogenic activity
71	Palatal myoclonus
72	Myokymia
73	Facial synkinesis
74	Hemifacial spasms
75	Extraocular muscle activity
76	Tremor activity
77	Myoclonic activity
78	Periodic movements of sleep
79	Periodic movements of sleep with arousals
Artifactual Activity[H]	
80	Unspecified artifacts
81	Electrode/instrumental artifacts
82	Movement artifacts
83	Sweat or galvanic skin artifacts
84	Pulse artifacts
85	EKG artifacts
86	Respiratory artifacts
87	Glossokinetic artifacts
88	Swallowing/chewing/sucking artifacts
89	External interference artifacts
Special Respiratory and Cardiovascular Events	
90	Unspecified cardiorespiratory events
91	Apneas or hypopneas with ventilatory effort
92	Apneas or hypopneas with little or no ventilatory effort
93	Oxygen desaturations
94	Sinus dysrhythmias
95	Supraventricular dysrhythmias
96	Ventricular dysrhythmias or asystoles
97	Systolic hypotensive episodes
98	Diastolic hypotensive episodes
99	[Reserved]

[A] Arrhythmic is the same as polymorphic. Intermittent rhythmic delta activity (IRDA) may be used to represent activity with frontal (FIRDA), occipital (OIRDA), or temporal (TIRDA) predominance.

[B] Sleep stage shifts, arousals, and awakenings are detected sleep events, not activities. POSTS also refers to cone-shaped or O waves.

[C] Unspecified epileptiform discharges refer to otherwise unclassified sharp waveforms or paroxysmal activity. Small sharp spikes are also known as benign sporadic sleep spikes or benign epileptiform transients of sleep. Phantom spike and wave is also known as 6 Hz spike and wave. Lambda waves also include slow lambdas of youth or shut-eye waves. Rhythmic theta of drowsiness may be used to represent activity with temporal (RTTD/RMTD) or other localization.

[D] Unspecified ictal discharges refer to otherwise unclassified seizure activity. Multiple spikes are equivalent to polyspikes. Sharp and slow wave complexes are equivalent to slow spike and wave complexes. Rhythmic sharp waves may be used to describe an ictal or a pseudoictal discharge.

[E] Periodic epileptiform discharges may refer to PLEDS as well as nonlateralized periodic discharges. Periodic suppressions refers to recordings with background activity of higher amplitude punctuated by relatively brief periods of suppression [for example, tracé alternant]; the values of duration, abundance, etc., describe characteristics of the suppressions. Periodic bursts with suppression refers to recordings with generally suppressed background activity punctuated by relatively brief bursts of higher amplitude activity [for example, burst suppression or tracé discontinu]; the values of duration, abundance, etc., describe characteristics of the bursts.

[F] Rapid eye movements can include REMs of sleep and rapid blinks or eye movements, such as eye flutter, during wakefulness.

[G] These may be seen in EEG or EMG/accelerometer channels.

[H] Instrumental artifacts include electrode, electrostatic, channel sway, etc.; external interference artifacts include line frequency and others.

TABLE B-8 Example Test/Observation ID Codes for EEG and Related Studies

Code	Description
95816.00000000004	EEG recording: recording duration [that is, total recording time in minutes]
95816.0101	EEG recording, with standard conditions while awake with eyes closed
95816.01010000102	EEG recording, with standard conditions while awake with eyes closed: background activity amplitude
95816.01010000441	EEG recording, with standard conditions while awake with eyes closed: spike and wave complexes abundance
95816.01010000950	EEG recording, with standard conditions while awake with eyes closed: ventricular heart rate
95816.01019901	EEG recording, with standard conditions while awake with eyes closed: number of samples [that is, number of epochs]
95816.01019902123	EEG recording, with standard conditions while awake with eyes closed: mean alpha activity frequency
95816.01019903123	EEG recording, with standard conditions while awake with eyes closed: standard deviation of alpha activity frequency
95816.31010000662	EEG recording, during photic stimulation while awake with eyes closed: photic driving activity amplitude
95816.3151	EEG recording, during photic stimulation while awake with eyes open
95816.61010000126	EEG recording, while performing mental arithmetic while awake with eyes closed: alpha activity reactivity
95816.9100	EEG recording, during square wave calibration
95819.01019902122	Awake and sleep EEG recording, with standard conditions while awake with eyes closed: mean alpha activity amplitude
95819.08030000471	Awake and sleep EEG recording, after sleep deprivation while asleep with eyes closed: sharp and slow wave complexes abundance
95829.0200	Electrocorticogram recording at surgery, before surgical resection
95951.0137	24-h combined EEG/video monitoring, with standard conditions during absence seizure with eyes closed
95951.01370000444	24-h combined EEG/video monitoring, with standard conditions during absence seizure with eyes closed: spike and wave complexes duration

TABLE B-9 Example Test/Observation ID Codes for PSG and Related Studies

Code	Description
95805.01000000057	Multiple sleep latency test, with standard conditions: stage I sleep activity latency [begin record to onset sleep]
95808.00000000004	Polysomnogram, recording 1-3 sleep parameters: recording duration [lights out time]
95808.01030000004	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: recording duration [sleep time]
95808.01030000031	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: REM sleep activity abundance [fraction (unitless) or percent (units=%) of REM sleep recorded in REM sleep periods = REM sleep efficiency]
95808.01030000033	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: REM sleep activity frequency [may mean: 1-frequency of background activity during REM periods (units=hz); 2-number REM periods per hour (units=/hr); or 3-total number REM periods (unitless)]
95808.01030000034	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: REM sleep activity duration [time from beginning to end of REM sleep]
95808.01030000037	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: REM sleep activity latency [time from sleep onset to first REM period]
95808.01030000201	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: sleep activity abundance [fraction (unitless) or % (units=%) time asleep = sleep efficiency]
95808.01030000204	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: sleep activity duration [total duration of all epochs sleep activity (all stages)]
95808.01030000273	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: sleep stage shifts frequency [number of shifts in sleep stage (units=/hr or unitless)]
95808.01030000293	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: awakenings frequency [number of waking episodes after sleep onset (units=/hr or unitless)]
95808.01030000923	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: apneas or hypopneas with little or no ventilatory effort frequency [central apnea index]
95808.01030134010	Polysomnogram, recording 1-3 sleep parameters, with standard conditions while asleep with eyes closed: sample number 134 sleep stage

TABLE B-10 CPT-4 Codes for EMG and Related Studies

Code	Description
9586X	EMG studies
51785	Anal or urethral sphincter EMG
92265	Extraocular muscle EMG
95858	EMG during edrophonium test
95860	One extremity EMG with related paraspinals
95861	Two extremity EMG with related paraspinals
95863	Three extremity EMG with related paraspinals
95864	Four extremity EMG with related paraspinals
95867	Unilateral cranial nerve supplied muscle EMG
95868	Bilateral cranial nerve supplied muscle EMG
95869	Limited EMG of specific muscles
95872	Single fiber EMG
95875	Ischemic limb exercise EMG

TABLE B-11 EMG and Related Study Muscle Site Identifiers

Code	Description
Muscles of Head, Neck, Mouth, and Upper Extremity (T-13xxx)	
0	Recording from left
2	Recording from right
Muscles of Trunk, Perineum, and Lower Extremity (T-14xxx)	
1	Recording from left
3	Recording from right
4-9	[Reserved]

TABLE B-12 Standard EMG Waveform/Activity Identifiers

Code	Description
00	[Unspecified]
01	Unspecified potentials under voluntary control
02	Motor unit potentials
03	Doublets
04	Triplets
05	Multiplets
06-09	[Reserved]
10	Insertional activity
11	End plate noise
12	End plate spikes
13-19	[Reserved]
20	Unspecified iterative discharges
21	Fibrillation potentials
22	Positive sharp waves
23	Fasciculation potentials
24	Myotonic discharges
25	Complex repetitive discharges
26	Myokymic discharges
27	Neuromyotonic discharges
28	Cramp discharges
29	After-discharges
30-99	[Reserved]

TABLE B-13 Standard EMG Value Identifiers

Code	CE	Description
Any Waveforms or Activity		
0	RELA	[Unspecified]
9	PATT	Firing pattern
Potentials under Voluntary Control (waveform/activity codes 01-09)		
1	RELA	Activation
2	RELA	Amplitude
3	RELA	Area
4	RELA	Recruitment
5	RELA	Duration
6	RELA	Complexity
7	RELA	Variability
8	RELA	Rise time
Other Waveforms or Activity (waveform/activity codes 10-99)		
1	[A]	Abundance
2	LOHI	Amplitude
3	LOHI	Area
4	LOHI	Frequency
5	SHLO	Duration
6	SMLG	Complexity
7	SMLG	Variability
8	SHLO	Rise time

[A] Use **RELA** for insertional activity (code 10) and **ABUN** for others.

TABLE B-14 Single Fiber EMG Value Identifiers

Code	CE	Description
0	RELA	[Unspecified]
1	RELA	Jitter
2	RELA	Fraction of discharges with blocking
3	ABUN	Blocking
4	RELA	Number of discharges per site
5	RELA	Fiber density
6	RELA	Duration
7	RELA	Interspike interval
8-9	...	[Reserved]

TABLE B-15 NCS Proximal Nerve Site Identifiers

Code	Description
0	[Unspecified]
1	At associated CNS site
2	At associated nerve root site
3	At associated plexus site
4	At proximal arm or thigh site
5	At intermediate arm or thigh site
6	At distal arm or thigh site
7	At proximal forearm or leg site
8	At intermediate forearm or leg site
9	At distal forearm or leg site

TABLE B-16 Example Test/Observation ID Codes for EMG and Related Studies

Code	Description
95860.0882	One extremity EMG with related paraspinals, recording from left abductor pollicis brevis muscle
95860.08820000025	One extremity EMG with related paraspinals, recording from left abductor pollicis brevis muscle: motor unit potentials duration
95860.08820000101	One extremity EMG with related paraspinals, recording from left abductor pollicis brevis muscle: insertional activity abundance
95861.26600005	Two extremity EMG with related paraspinals, recording from right deltoid muscle: sample number 5
95861.26600005021	Two extremity EMG with related paraspinals, recording from right deltoid muscle: sample number 5 motor unit potentials activation
95863.17319903025	Three extremity EMG with related paraspinals, recording from left gastrocnemius muscle, lateral head: standard deviation of motor unit potentials duration
95864.34109902026	Four extremity EMG with related paraspinals, recording from right iliopsoas muscle: mean motor unit potentials complexity
95867.02909901	Unilateral cranial nerve supplied muscle EMG, recording from left orbicularis oris muscle: number of samples
95867.02909908026	Unilateral cranial nerve supplied muscle EMG, recording from left orbicularis oris muscle: fraction of samples with abnormal motor unit potentials complexity
95869.04000000211	Limited EMG of specific muscles, recording from left diaphragm: fibrillation potentials abundance
95872.08409902001	Single fiber EMG, recording from left extensor digitorum muscle: mean jitter
95872.08409902002	Single fiber EMG, recording from left extensor digitorum muscle: mean fraction of discharges with blocking
95872.08409908003	Single fiber EMG, recording from left extensor digitorum muscle: fraction of samples with abnormal blocking

TABLE B-17 CPT-4 Codes for NCS and Related Studies

Code	Diagnosis	Description
9590X	...	Nerve conduction studies
95900	MNCD	Motor nerve conduction study
95903	MNCD	Motor nerve conduction study with F-wave
95904	SNCD	Sensory nerve conduction study
95933	SNCD	Orbicularis oculi (blink) reflex study
95934	MNCD	H-reflex study, gastrocnemius/soleus
95935	MNCD	[Obsolete][4]
95936	MNCD	H-reflex study other than gastrocnemius/soleus
95937	NMJD	Neuromuscular junction or periodic paralysis study

[4]This code has been deleted in the current CPT-4; while it should still be accepted by receiver systems that conform to this specification, it may be treated as equivalent to code 95903, 95934, or 95936, and transmitter systems are encouraged to use the latter codes instead.

TABLE B-18 Motor NCS Stimulus Type and Site Identifiers

Code	Description
Muscles of Head, Neck, Mouth, and Upper Extremity (T-13xxx)	
0	With electric stimulation, recording from left
2	With electric stimulation, recording from right
4	With magnetic stimulation, recording from left
6	With magnetic stimulation, recording from right
8	[Reserved]
Muscles of Trunk, Perineum, and Lower Extremity (T-14xxx)	
1	With electric stimulation, recording from left
3	With electric stimulation, recording from right
5	With magnetic stimulation, recording from left
7	With magnetic stimulation, recording from right
9	[Reserved]

TABLE B-19 Motor NCS Waveform Identifiers

Code	Description
1	CMAP
2	F-wave
3	H-reflex
4	C (long loop) reflex
5	Silent period
6	Axon reflex
7-9	[Reserved]

TABLE B-20 Neuromuscular Junction Testing Waveform Identifiers

Code	Description
1	CMAP without exercise after single stimulus
2	CMAP without exercise after repetitive slow-rate stimuli
3	CMAP without exercise after repetitive fast-rate stimuli
4	CMAP with exercise after single stimulus
5	CMAP with exercise after repetitive slow-rate stimuli
6	CMAP with exercise after repetitive fast-rate stimuli
7	CMAP after exercise after single stimulus
8	CMAP after exercise after repetitive slow-rate stimuli
9	CMAP after exercise after repetitive fast-rate stimuli

TABLE B-21 Motor NCS Value Identifiers for Waveform Characteristics

Code	Description
0	Amplitude
1	Area
2	Motor unit number
3	Latency
4	Duration
5	Amplitude ratio
6	Area ratio
7	Ipsilateral to contralateral latency difference
8	Ipsilateral reference nerve latency difference
9	Conduction velocity

TABLE B-22 Sensory NCS Stimulus Type and Site Identifiers

Code	Description
Stimulation of Spinal Nerves (T-X9###)	
0	Recording orthodromically, with electric stimulation of left
1	With electric stimulation, recording antidromically from left
2	Recording orthodromically, with electric stimulation of right
3	With electric stimulation, recording antidromically from right
4	Recording orthodromically, with magnetic stimulation of left
5	With magnetic stimulation, recording antidromically from left
6	Recording orthodromically, with magnetic stimulation of right
7	With magnetic stimulation, recording antidromically from right
Stimulation of Cranial Nerves (T-X8###)	
8	Recording with stimulation of left
9	Recording with stimulation of right

TABLE B-23 Sensory NCS Waveform Identifiers

Code	Description
1	SNAP
2	R1
3	R2
4	Contralateral R2
5-9	[Reserved]

TABLE B-24 Sensory NCS Value Identifiers for Waveform Characteristics

Code	Description
0	Amplitude
1	Area
2	Peak latency
3	Onset latency
4	Duration
5	Amplitude ratio
6	Area ratio
7	Ipsilateral to contralateral latency difference
8	Ipsilateral reference nerve latency difference
9	Conduction velocity

TABLE B-25 NCS Stimulus Characteristics Identifiers

Code	CE	Description
0	...	[Unspecified]
1	LOHI	Stimulus rate
2	SHLO	Stimulus duration
3	LOHI	Stimulus intensity
4-9	...	[Reserved]

TABLE B-26 Example Test/Observation ID Codes for NCS and Related Studies

Code	Description
95900.28829	Motor nerve conduction study, with electric stimulation, recording from right abductor pollicis brevis muscle, at distal forearm or leg site
95900.37816000019	Motor nerve conduction study, with electric stimulation, recording from right extensor digitorum brevis muscle, at distal arm or thigh site: CMAP conduction velocity
95903.28829000053	Motor nerve conduction study with F-wave, with electric stimulation, recording from right abductor pollicis brevis muscle, at distal forearm or leg site: silent period latency
95904.01859	Sensory nerve conduction study, recording orthodromically, with electric stimulation of left median nerve, palmar branch, at distal forearm or leg site
95904.01859000012	Sensory nerve conduction study, recording orthodromically, with electric stimulation of left median nerve, palmar branch, at distal forearm or leg site: SNAP peak latency
95904.31886000015	Sensory nerve conduction study, with electric stimulation, recording antidromically from right median nerve, proper digital palmar nerves, at distal arm or thigh site: SNAP amplitude ratio
95933	Orbicularis oculi (blink) reflex study
95933.82420000023	Orbicularis oculi (blink) reflex study, recording with stimulation of left supraorbital nerve: R1 onset latency
95934.17406000033	H-reflex study, gastrocnemius/soleus, with electric stimulation, recording from left soleus muscle, at distal arm or thigh site: H-reflex latency
95937.28829000110	Neuromuscular junction or periodic paralysis study, with electric stimulation, recording from right abductor pollicis brevis muscle, at distal forearm or leg site: sample number 1 CMAP without exercise after single stimulus amplitude
95937.28829000201	Neuromuscular junction or periodic paralysis study, with electric stimulation, recording from right abductor pollicis brevis muscle, at distal forearm or leg site: sample number 2 stimulus rate
95937.28829990250	Neuromuscular junction or periodic paralysis study, with electric stimulation, recording from right abductor pollicis brevis muscle, at distal forearm or leg site: mean CMAP with exercise after repetitive slow-rate stimuli amplitude

TABLE B-27 Qualified CPT-4 Codes for EP and Related Studies

Code	Diagnosis	Description
9592X	...	Evoked potential studies
92275.0	ERGD	Electroretinogram study
92275.5	SSED	Steady-state electroretinogram study
92275.1-4,6-9		[Reserved]
92280.0-9		[Obsolete][A]
92584.0	ECOD	Electrocochleogram study
92584.5	SSED	Steady-state electrocochleogram study
92584.1-4,6-9		[Reserved]
92585.0	BAED	Brainstem auditory evoked potential study
92585.1	MAED	Middle-latency auditory evoked potential study
92585.2	LAED	Long-latency auditory evoked potential study
92585.3	LAED	Long-latency auditory event-related potential study
92585.4	...	[Reserved]
92585.5	SSED	Steady-state short-latency auditory evoked potential study
92585.6	SSED	Steady-state middle-latency auditory evoked potential study
92585.7	SSED	Steady-state long-latency auditory evoked potential study
92585.8-9	SSED	[Reserved]
95925.0	[B]	Upper extremity somatosensory evoked potential study
95925.1	[B]	Upper extremity somatosensory event-related potential study
95925.2-3	...	[Reserved]
95925.4	MRPD	Upper extremity movement-related potential study
95925.5	SSED	Upper extremity steady-state somatosensory evoked potential study
95925.6-9	SSED	[Reserved]
95926.0-9		[Same as 95925.0-9 except that *lower extremity* replaces *upper extremity*]
95927.0-9		[Same as 95925.0-9 except that *trunk or head* replaces *upper extremity*]
95930.0	VEPD	Visual evoked potential study
95930.1	VEPD	Visual event-related potential study
95930.2	DVED	Diffuse light visual evoked potential study
95930.3	DVED	Diffuse light visual event-related potential study
95930.4	...	[Reserved]
95930.5	SSED	Steady-state visual evoked potential study
95930.6	SSED	[Reserved]
95930.7	SSED	Steady-state diffuse light visual evoked potential study
95930.8-9	SSED	[Reserved]

[A]Code 92280 has been deleted in the current CPT-4; while it should still be accepted by receiver systems that conform to this Technical Standard, it may be treated as equivalent to code 95930, and transmitter systems are encouraged to use the latter code instead.

[B]Diagnostic code tables for SEPs depend on the nerve tested:

MSED	[for median/ulnar nerve SEPs]
PSED	[for peroneal nerve SEPs]
TSED	[for tibial nerve SEPs]
SEPD	[for other nerve SEPs]

TABLE B-28 VEP Visual Field Identifiers

Code	Description
0	[Unspecified]
1	Full field
2	Left half field
3	Right half field
4	Top half field
5	Bottom half field
6	Left top quadrant field
7	Left bottom quadrant field
8	Right top quadrant field
9	Right bottom quadrant field

TABLE B-29 VEP Stimulus Pattern Identifiers

Code	Description
0	[Unspecified]
1	Checkerboard pattern
2	Horizontally oriented bar grating pattern
3	Vertically oriented bar grating pattern
4	Horizontally oriented sine wave grating pattern
5	Vertically oriented sine wave grating pattern
6	Windmill grating pattern
7	Dart board pattern
8	Complex pattern
9	[Reserved]

TABLE B-30 VEP Stimulus Type and Side Identifiers

Code	Description
0	[Unspecified]
1	Reversal stimuli to left eye
2	Reversal stimuli to right eye
3	Reversal stimuli to both eyes
4	Sinusoidally modulated stimuli to left eye
5	Sinusoidally modulated stimuli to right eye
6	Sinusoidally modulated stimuli to both eyes
7	Flash stimuli to left eye
8	Flash stimuli to right eye
9	Flash stimuli to both eyes

TABLE B-31 AEP Stimulus Polarity Identifiers

Code	Description
0	[Unspecified]
1	Rarefaction polarity
2	Condensation polarity
3	Alternating polarity
4-9	[Reserved]

TABLE B-32 AEP Stimulus Type Identifiers

Code	Description
0	[Unspecified]
1	Click stimuli
2	Filtered click stimuli
3	Tone stimuli
4	Gated sine wave stimuli
5	Logon stimuli
6-9	[Reserved]

TABLE B-33 AEP Stimulus Side Identifiers

Code	Description
0	[Unspecified]
1	To left ear
2	To right ear
3	To both ears
4-9	[Reserved]

TABLE B-34 SEP Stimulus Type and Side Identifiers

Code	Description
Stimulation of Spinal Nerves (T-X9###)	
0	Electric stimulation of left
1	Electric stimulation of right
2	Electric stimulation of bilateral
3	Nonelectric stimulation of left
4	Nonelectric stimulation of right
5	Nonelectric stimulation of bilateral
Stimulation of Cranial Nerves (T-X8###)	
6	Stimulation of left
7	Stimulation of right
8	Stimulation of bilateral
9	[Reserved]

TABLE B-35 SEP Nerve Identifiers

Code	Description
Spinal Nerves	
03	Cervical nerve
14	Musculocutaneous/lateral antebrachial cutaneous nerve
16	Medial antebrachial cutaneous nerve
17	Ulnar nerve
18	Median nerve
19	Radial nerve
23	Thoracic nerve
30	Lumbar nerve
36	Lateral femoral cutaneous nerve
38	Femoral/saphenous nerve
40	Sacral nerve
45	Tibial nerve
47	Sural nerve
48	Plantar nerves
49	Common peroneal nerve
51	Superficial peroneal nerve
55	Pudendal nerve
Cranial Nerves	
15	Trigeminal nerve
21	Ophthalmic nerve
26	Maxillary nerve
33	Mandibular nerve

TABLE B-36 MRP Movement Side and Region Identifiers

Code	Description
Movements of Upper Extremities (T-Y8###)	
0	Movement of left
1	Movement of right
2	Movement of bilateral
Movements of Lower Extremities (T-Y9###)	
3	Movement of left
4	Movement of right
5	Movement of bilateral
Movements of Head and Neck (T-Y0###)	
6	Movement of left
7	Movement of right
8	Movement of bilateral
9	[Reserved]

TABLE B-37 Steady-state EP Harmonic Identifiers

Code	Description
0	[Unspecified]
1	Fundamental
2	Second harmonic
3	Third harmonic
4	Fourth harmonic
5	Fifth harmonic
6	Sixth harmonic
7	Fundamental-second harmonic
8	Fundamental-third harmonic
9	Fundamental-fourth harmonic

TABLE B-38 Transient ERG and VEP Peak Identifiers

Code	ERGs	Patterned VEPs	Diffuse Light VEPs
0	[Unspecified]	[Unspecified]	[Unspecified]
1	Early receptor potential	P50 peak	N1 peak
2	A wave	N75 peak	P1 peak
3	B wave	P100 peak	N2 peak
4	C wave	N145 peak	P2 peak
5	[Reserved]	P175 peak	N3 peak
6	[Reserved]	P300 peak	P3 peak
7	A wave-B wave	N75-P100 peak	P1-N2 peak
8	B wave-C wave	P100-N145 peak	N2-P2 peak
9	A wave-C wave	N75-N145 peak	P1-P2 peak

TABLE B-39 Transient ECoG and AEP Peak Identifiers

Code	ECoGs	BAEPs	MLAEPs	LLAEPs
0	[Unspecified]	[Unspecified]	[Unspecified]	[Unspecified]
1	Cochlear microphonic	Peak I	N0 peak	Nb peak
2	[Reserved]	Peak II	P0 peak	P1 peak
3	Summating potential	Peak III	Na peak	N1 peak
4	[Reserved]	Peak IV	Pa peak	P2 peak
5	Nerve action potential peak	Peak V	Nb peak	N2 peak
6	[Reserved]	Peak VI	Pb peak	P300 peak
7	Cochlear micro-summating potential	Peak I-III	N0-Na peak	Nb-N1 peak
8	Summating potential-nerve action potential	Peak III-V	Na-Nb peak	N1-N2 peak
9	Cochlear micro-nerve action potential	Peak I-V	N0-Nb peak	Nb-N2 peak

TABLE B-40 Transient SEP Peak Identifiers

Code	Median/Ulnar SEPs	Peroneal SEPs	Tibial SEPs	Other SEPs
0	[Unspecified]	[Unspecified]	[Unspecified]	[Unspecified]
1	N9 peak	Lumbar peak	Popliteal peak	Peak I
2	N11 peak	Low thoracic peak	Lumbar peak	Peak II
3	N13 peak	High thoracic peak	Thoracic peak	Peak III
4	N20 peak	P27 peak	P37 Peak	Peak IV
5	P30 peak	N35 peak	N45 Peak	Peak V
6	P300 peak	P300 peak	P300 peak	P300 Peak
7	N9-N13 peak	Lumb-hi thor peak	Poplit-thor peak	Peak I-III
8	N13-N20 peak	Hi thor-P27 peak	Thor-P37 peak	Peak III-IV
9	N9-N20 peak	Lumbar-P27 peak	Poplit-P37 peak	Peak I-IV

TABLE B-41 MRP Peak Identifiers

Code	Meaning
0	[Unspecified]
1	Bereitschaftspotential
2	Negative slope
3	N1 peak
4	P1 peak
5	N2 peak
6	P2 peak
7	Bereitschaftspotential-N1 peak
8	N1-N2 peak
9	Bereitschaftspotential-N2 peak

TABLE B-42 EP Value Identifiers for Peak/Harmonic Characteristics

Code	CE	Description
All EPs		
2	RELA	Amplitude
3	MRPH	Morphology
5	RELA	Ipsilateral to contralateral amplitude ratio
6	...	[Reserved]
8	RELA	Amplitude ratio
9	...	[Reserved]
Transient EPs		
1	RELA	Latency
4	RELA	Ipsilateral to contralateral latency difference
7	RELA	Latency difference
Steady-state EPs		
1	RELA	Phase
4	RELA	Ipsilateral to contralateral phase difference
7	RELA	Phase difference

TABLE B-43 EP Stimulus Characteristics Identifiers

Code	CE	Description
All EPs		
0	...	[Unspecified]
1	LOHI	Stimulus rate
2	SHLO	Stimulus duration
3	LOHI	Stimulus intensity
4	ABUN	Stimulus abundance
9	...	[Reserved]
VEPs		
5	COLO	Visual stimulus color
6	LOHI	Visual stimulus contrast
7	SMLG	Visual pattern element size
8	SMLG	Visual field size
AEPs		
5	LOHI	Auditory stimulus frequency

TABLE B-44 Test/Observation ID Codes for Body Temperature Measurements

Code	CE	Description
1000.1	TMPM	Temperature method
1000.2	LOHI	Oral temperature
1000.3	LOHI	Rectal temperature
1000.4	LOHI	Axillary temperature
1000.5	LOHI	Other temperature
1000.6	[A]	Other temperature source

[A]The code table usually used is **SNM+** and the specific code table identifier is **TOPO**.

TABLE B-45 Example Test/Observation ID Codes for EP and Related Studies

Code	Description
92275.0107	Electroretinogram study, full field flash stimuli to left eye
92275.51540002	Steady-state electroretinogram study, full field vertically oriented sine wave grating pattern sinusoidally modulated stimuli to left eye: sample number 2
95930.0221000034	Visual evoked potential study, left half field horizontally oriented bar grating pattern reversal stimuli to left eye: P100 peak ipsilateral to contralateral latency difference
95930.2008000041	Diffuse light visual evoked potential study, flash stimuli to right eye: P2 peak latency
95930.5154000211	Steady-state visual evoked potential study, full field vertically oriented sine wave grating pattern sinusoidally modulated stimuli to left eye: sample number 2 fundamental phase
95930.7004000210	Steady-state diffuse light visual evoked potential study, sinusoidally modulated stimuli to left eye: sample number 2 stimulus rate
92584.0312000051	Electrocochleogram study, alternating polarity click stimuli to right ear: nerve action potential peak latency
92585.0111000030	Brainstem auditory evoked potential study, rarefaction polarity click stimuli to left ear: stimulus intensity
92585.0111000098	Brainstem auditory evoked potential study, rarefaction polarity click stimuli to left ear: peak I-V amplitude ratio
92585.1	Middle-latency auditory evoked potential study
92585.2043000231	Long-latency auditory evoked potential study, gated sine wave stimuli to both ears: sample number 2 N1 peak latency
92585.3043000240	Long-latency auditory event-related potential study, gated sine wave stimuli to both ears: sample number 2 stimulus abundance
95925.0118000097	Upper extremity somatosensory evoked potential study, electric stimulation of right median nerve: N9-N20 peak latency difference
95925.4083000013	Upper extremity movement-related potential study, movement of left middle finger: Bereitschaftspotential morphology
95926.0245	Lower extremity somatosensory evoked potential study, electric stimulation of bilateral tibial nerve

TABLE B-46 Focal Anatomic Localization Codes

Code	Description
Group 1 Codes (select one only)	
1000	Left
2000	Right
3000	Bilateral
4000	Midline
5000	Generalized, maximal left
6000	Generalized, maximal right
7000	Left hemisphere, maximal
8000	Right hemisphere, maximal
9000	Independent left and right
A000	Independent left and right hemisphere, maximal left
B000	Independent left and right hemisphere, maximal right
C000	Left and midline
D000	Right and midline
Group 2 Codes (select any number)	
0001	Frontopolar
0002	Frontal
0004	Lateral frontal
0010	Central
0020	Parietal
0040	Occipital
0100	Anterior temporal
0200	Midtemporal
0400	Posterior temporal

TABLE B-47 Examples of Anatomic Localizations for EEG and EP Studies

Code	Description
EEG Waveforms or Activities	
0004	In midline
0016	Generalized, maximal right hemisphere
0018	Generalized, maximal posterior head region
1030	Left central and parietal
1300	Left anterior temporal and midtemporal
2200	Right midtemporal
2307	Right frontopolar and frontal and lateral frontal and anterior temporal and midtemporal
3106	Bilateral frontal and lateral frontal and anterior temporal
3210	Bilateral central and midtemporal
4010	Midline central
4012	Midline frontal and central
5002	Generalized, maximal left frontal
5460	Generalized, maximal left parietal and occipital and posterior temporal
6012	Generalized, maximal right frontal and central
6030	Generalized, maximal right central and parietal
7007	Left hemisphere, maximal frontopolar and frontal and lateral frontal
7060	Left hemisphere, maximal parietal and occipital
8060	Right hemisphere, maximal parietal and occipital
8200	Right hemisphere, maximal midtemporal
9200	Independent left and right midtemporal
9210	Independent left and right central and midtemporal
EP Studies	
0001	On left
0002	On right
0003	Bilaterally

TABLE B-48 Generalized and Regional Anatomic Localization Codes

Code	Description	Code	Description	Code	Description
0000	[Unspecified]	0104	FCz electrode	0166	CP6 electrode
0001	On left	0105	Cz electrode	0167	P6 electrode
0002	On right	0106	CPz electrode	0168-0171	[Reserved]
0003	Bilaterally	0107	Pz electrode	0172	AF7 electrode
0004	In midline	0108	POz electrode	0173	F7 electrode
0005	Proximally	0109	Oz electrode	0174	FT7 electrode
0006	Distally	0110	Iz electrode	0175	T7 (T3) electrode
0007	Medially	0111	Fp1 electrode	0176	TP7 electrode
0008	Laterally	0112	[Reserved]	0177	P7 (T5) electrode
0009	[Reserved]	0113	F1 electrode	0178	PO7 electrode
0010	Generalized	0114	FC1 electrode	0179-0181	[Reserved]
0011	Left hemisphere	0115	C1 electrode	0182	AF8 electrode
0012	Right hemisphere	0116	CP1 electrode	0183	F8 electrode
0013	Anterior head region	0117	P1 electrode	0184	FT8 electrode
0014	Posterior head region	0118	[Reserved]	0185	T8 (T4) electrode
0015	Generalized, maximal left hemisphere	0119	O1 electrode	0186	TP8 electrode
0016	Generalized, maximal right hemisphere	0120	[Reserved]	0187	P8 (T6) electrode
0017	Generalized, maximal anterior head region	0121	Fp2 electrode	0188	PO8 electrode
0018	Generalized, maximal posterior head region	0122	[Reserved]	0189-0192	[Reserved]
0019	Multifocal	0123	F2 electrode	0193	F9 electrode
0020	In left hemisphere cortical surface leads	0124	FC2 electrode	0194	FT9 electrode
0021	In left frontal cortical surface leads	0125	C2 electrode	0195	T9 electrode
0022	In left parietal cortical surface leads	0126	CP2 electrode	0196	TP9 electrode
0023	In left occipital cortical surface leads	0127	P2 electrode	0197	P9 electrode
0024	In left temporal cortical surface leads	0128	[Reserved]	0198-0202	[Reserved]
0025	In right hemisphere cortical surface leads	0129	O2 electrode	0203	F10 electrode
0026	In right frontal cortical surface leads	0130-0131	[Reserved]	0204	FT10 electrode
0027	In right parietal cortical surface leads	0132	AF3 electrode	0205	T10 electrode
0028	In right occipital cortical surface leads	0133	F3 electrode	0206	TP10 electrode
0029	In right temporal cortical surface leads	0134	FC3 electrode	0207	P10 electrode
0030-0039	[Same as 0020-0029 for *depth* instead of *surface* leads]	0135	C3 electrode	0208-0212	[Reserved]
0040-0049	[Same as 0020-0029 for *surface and depth* leads]	0136	CP3 electrode	0213	F11 electrode
0050	Left hemisphere, maximal anterior	0137	P3 electrode	0214	FT11 electrode
0051	Left hemisphere, maximal posterior	0138	PO3 electrode	0215	T11 electrode
0052	Right hemisphere, maximal anterior	0139-0141	[Reserved]	0216	TP11 electrode
0053	Right hemisphere, maximal posterior	0142	AF4 electrode	0217	P11 electrode
0054	Anterior head region, maximal left	0143	F4 electrode	0218-0222	[Reserved]
0055	Anterior head region, maximal right	0144	FC4 electrode	0223	F12 electrode
0056	Anterior head region, maximal in midline	0145	C4 electrode	0224	FT12 electrode
0057	Posterior head region, maximal left	0146	CP4 electrode	0225	T12 electrode
0058	Posterior head region, maximal right	0147	P4 electrode	0226	TP12 electrode
0059	Posterior head region, maximal in midline	0148	PO4 electrode	0227	P12 electrode
0060	Independent left and right hemisphere	0149-0152	[Reserved]	0228-0249	[Reserved]
0061-0064	[Reserved]	0153	F5 electrode	0250	A1 electrode
0065	Independent left and right, maximal left hemisphere	0154	FC5 electrode	0251	A2 electrode
0066	Independent left and right, maximal right hemisphere	0155	C5 electrode	0252	T1 electrode
0067	Independent left and right, maximal anterior	0156	CP5 electrode	0253	T2 electrode
0068	Independent left and right, maximal posterior	0157	P5 electrode	0254	Pg1 electrode
0069-0099	[Reserved]	0158-0162	[Reserved]	0255	Pg2 electrode
0100	Nz electrode	0163	F6 electrode	0256	Sp1 electrode
0101	Fpz electrode	0164	FC6 electrode	0257	Sp2 electrode
0102	AFz electrode	0165	C6 electrode	0258-0999	[Reserved]
0103	Fz electrode				

TABLE B-49 Heart Rhythm Codes

Code	Description
00	[Unspecified]
01	Artificial pacemaker rhythm
02	Sinus bradycardia
03	Normal sinus rhythm
04	Sinus arrhythmia
05	Sinus tachycardia
06	Atrial premature contractions
07	Atrial tachycardia
08	Atrial flutter
09	Atrial fibrillation
10	Junctional complexes
11	Junctional escape rhythm
12	Junctional tachycardia
13	Ventricular premature contractions
14	Paired ventricular premature contractions
15	Bigeminy
16	Trigeminy
17	Ventricular escape rhythm
18	Ventricular tachycardia
19	Ventricular fibrillation
20	Ventricular asystole
21-99	[Reserved]

TABLE B-50 Sleep and Wake Stage Codes

Code	Description
0	[Unspecified]
1	Unstageable
2	Stage W (wake)
3	REM sleep
4	REM-spindle sleep
5	Stage I sleep
6	Stage II sleep
7	Stage III sleep
8	Stage IV sleep
9	Alpha-delta sleep

TABLE B-51 Waveform Characteristics Codes

Code	Description
0	[Unspecified]
1	Asynchronous
2	Synchronous
3	Bisynchronous
4	Positive polarity
5	Negative polarity
6	Dipolar
7	Subclinical discharge with repetitive
8	Subclinical seizure discharge with repetitive
9	Clinical seizure discharge with repetitive

TABLE B-52 Firing Pattern Codes

Code	Description
0	[Unspecified]
1	Incrementing frequency
2	Decrementing frequency
3	Irregular
4	Regular
5	Waxing and waning
6	Continuous
7	Burst firing
8	Stable
9	Unstable

TABLE B-53 Peak Morphology Codes

Code	Description
0	[Unspecified]
1	Normal
2	Unrecognizable
3	Fused
4	W or M shape
5	Asymmetric
6-9	[Reserved]

TABLE B-54 Visual Stimulus Color Codes

Code	Description
0	White
1	Red
2	Orange
3	Yellow
4	Green
5	Blue
6	Indigo
7	Violet
8	Magenta
9	Cyan

TABLE B-55 Temperature Method Codes

Code	Description
0	[Unspecified]
1	Glass thermometer
2	Digital probe
3	Color strip
4	Infrared sensor
5	Needle probe
6	Thermistor
7	Thermocouple
8-9	[Reserved]

TABLE B-56 Relative Grading System for Quantitative Results

Code	Description
0	Very markedly decreased
1	Markedly decreased
2	Decreased
3	Mildly decreased
4	Normal
5	Abnormal
6	Mildly increased
7	Increased
8	Markedly increased
9	Very markedly increased

TABLE B-57 Absolute/Relative Grading Systems for Quantitative Results

Code	LOHI Description	SHLO Description	SMLG Description
0	Low	Short	Small
1	Markedly decreased	Markedly decreased	Markedly decreased
2	Decreased	Decreased	Decreased
3	Mildly decreased	Mildly decreased	Mildly decreased
4	Normal	Normal	Normal
5	Moderate	Medium	Medium
6	Mildly increased	Mildly increased	Mildly increased
7	Increased	Increased	Increased
8	Markedly increased	Markedly increased	Markedly increased
9	High	Long	Large

TABLE B-58 Grading System for Abundance

Code	Description
0	Absent
1	Recorded
2	Possible
3	Very rare
4	Rare
5	Occasional
6	Frequent
7	Very frequent
8	Nearly continuous
9	Continuous

TABLE B-59 Grading System for Asymmetry

Code	Description
0	Very markedly asymmetric (decreased)
1	Markedly asymmetric (decreased)
2	Moderately asymmetric (decreased)
3	Mildly asymmetric (decreased)
4	Symmetric
5	Asymmetric
6	Mildly asymmetric (increased)
7	Moderately asymmetric (increased)
8	Markedly asymmetric (increased)
9	Very markedly asymmetric (increased)

TABLE B-60 Grading System for Reactivity

Code	Description
0	Abnormally reactive
1	Unreactive
2	Slightly reactive
3	Moderately reactive
4	Very reactive
5	Normally reactive
6	Paradoxically reactive
7-9	[Reserved]

TABLE B-61 Special Diagnostic Codes for All Electroneurophysiologic Study Types

Code	Description
0	Abnormal
1	Normal
2	Technically difficult
3	Technically unsatisfactory
4	Not completed
5	Unsuccessful or inconclusive
6	Not attempted
7	No change
8	No activation
9	[Reserved]

TABLE B-62 Example Diagnostic Codes for EEG and Related Studies

Code	Description
0110	Absent background activity [that is, electrocerebral inactivity]
1108	Recorded stage IV sleep activity
1169	Recorded electroretinogram
1173	Recorded facial synkinesis
1703	Markedly decreased latency REM sleep activity [for example, sleep-onset REM]
2312	Decreased frequency alpha activity
2510	Moderately asymmetric (decreased) background activity
2612	Slightly reactive alpha activity
3509	Mildly asymmetric (decreased) alpha-delta sleep activity
3520	Mildly asymmetric (decreased) sleep activity
3521	Mildly asymmetric (decreased) sleep spindles
4146	Rare atypical spike and wave complexes
5132	Occasional wickets
5137	Occasional 14 and 6 Hz positive bursts
5158	Occasional periodic bursts with suppression [for example, burst suppression]
6128	Frequent arousals
6133	Frequent small sharp spikes
6143	Frequent multiple spikes
6147	Frequent sharp and slow wave complexes
6157	Frequent periodic suppressions [for example, tracé alternant]
6192	Frequent apneas or hypopneas with little or no ventilatory effort
7152	Very frequent periodic triphasic waves
7179	Very frequent periodic movements of sleep with arousals
7513	Moderately asymmetric (increased) mu activity
8213	Markedly increased amplitude mu activity
9848	Clinical seizure discharge with repetitive rhythmic sharp waves
519493	Occasional long duration oxygen desaturations
619215	Frequent high-amplitude bisynchronous theta activity
910218	Continuous low-amplitude arrhythmic delta activity
915353	Continuous moderate frequency periodic epileptiform discharges [for example, PLEDS]
919218	Continuous high-amplitude arrhythmic delta activity
91920354	Continuous high-amplitude low-frequency periodic complexes [for example, SSPE]

TABLE B-63 Example Diagnostic Codes for EMG and Related Studies

Code	Description
Standard EMG Studies	
0221	Low-amplitude fibrillation potentials
1202	Markedly decreased amplitude motor unit potentials
2110	Decreased abundance insertional activity
2402	Decreased recruitment motor unit potentials
3102	Mildly decreased activation motor unit potentials
4105	Rare multiplets
4502	Normal duration motor unit potentials
5121	Occasional fibrillation potentials
5225	Moderate-amplitude complex repetitive discharges
6202	Mildly increased amplitude motor unit potentials
7110	Increased abundance insertional activity
7602	Increased complexity motor unit potentials
8124	Nearly continuous myotonic discharges
8402	Markedly increased recruitment motor unit potentials
8702	Markedly increased variability motor unit potentials
9125	Continuous complex repetitive discharges
9502	Very markedly increased duration motor unit potentials
9526	Long duration myokymic discharges
419223	Rare high-amplitude fasciculation potentials
547926	Moderate-frequency burst firing myokymic discharges
599424	Waxing and waning high-frequency myotonic discharges
614921	Frequent regular fibrillation potentials
619526	Frequent long duration myokymic discharges
919925	Continuous unstable complex repetitive discharges
Single Fiber EMG Studies	
0300	Absent blocking
1300	Recorded blocking
3500	Mildly decreased fiber density
4700	Normal interspike interval
6200	Mildly increased fraction of discharges with blocking
7100	Increased jitter
7300	Very frequent blocking
7700	Increased interspike interval
8600	Markedly increased duration
757600	Increased fiber density increased duration

TABLE B-64 Example Diagnostic Codes for NCS and Related Studies

Code	Description
Motor NCS (MNCD)	
010	Very markedly decreased CMAP amplitude
119	Markedly decreased CMAP conduction velocity
212	Decreased CMAP motor unit number
254	Decreased silent period duration
315	Mildly decreased CMAP amplitude ratio
417	Normal CMAP ipsilateral to contralateral latency difference
543	Abnormal C (long loop) reflex latency
613	Mildly increased CMAP latency
723	Increased F-wave latency
733	Increased H-reflex latency
Neuromuscular Junction/Periodic Paralysis Studies (NMJD)	
220	Decreased CMAP without exercise after repetitive slow-rate stimuli amplitude
351	Mildly decreased CMAP with exercise after repetitive slow-rate stimuli area
770	Increased CMAP after exercise after single stimulus amplitude
Sensory NCS (SNCD)	
010	Very markedly decreased SNAP amplitude
119	Markedly decreased SNAP conduction velocity
417	Normal SNAP ipsilateral to contralateral latency difference
612	Mildly increased SNAP peak latency
643	Mildly increased contralateral R2 onset latency
723	Increased R1 onset latency
837	Markedly increased R2 ipsilateral to contralateral latency difference

TABLE B-65 Example Diagnostic Codes for EP and Related Studies

Code	Description
Steady-state EPs of any modality (SSED)	
777	Increased fundamental-second harmonic phase difference
ERGs (ERGD)	
122	Markedly decreased A wave amplitude
Pattern VEPs (VEPD)	
731	Increased P100 peak latency
Diffuse light VEPs (DVED)	
841	Markedly increased P2 peak latency
ECoGs (ECOD)	
012	Very markedly decreased cochlear microphonic amplitude
BAEPs (BAED)	
997	Very markedly increased peak I-V latency difference
MLAEPs (MAED)	
734	Increased Na peak ipsilateral to contralateral latency difference
LLAEPs (LAED)	
761	Increased P300 peak latency
Median/ulnar nerve SEPs (MSED)	
897	Markedly increased N9-N20 peak latency difference
Peroneal nerve SEPs (PSED)	
142	Markedly decreased P27 peak amplitude
Tibial nerve SEPs (TSED)	
543	Asymmetric P37 peak morphology
Other nerve SEPs (SEPD)	
741	Increased peak IV latency
MRPs (MRPD)	
213	Unrecognizable Bereitschaftspotential morphology

C . EXAMPLE MESSAGE FOR NEUROPHYSIOLOGICAL DATA

C.1. This appendix gives an example message in NCCLS LIS 5-A format (Fig. C-1) which contains the results of an EEG study performed on one subject, a combined motor and sensory nerve conduction study and EMG on another subject, and a visual evoked potential study on a third subject. The EEG recording is transmitted using WAV category result segments with the RP data type, pointing to a binary EEG data file which contains the actual waveform data. The nerve conduction studies, EMG, and evoked potential study are transmitted using WAV category result segments with the CM data type, which contain decimally-encoded actual waveform data.

C.2 The EEG example illustrates a variety of segment types and result segment categories, and demonstrates a number of features of the ANA and STM category result segments, including their use in calibration, sharp wave detection, and photic stimulation. During calibration, each calibration pulse leads to an ANA category result segment which contains calibration data for each channel. During the EEG recording, each occurrence of a sharp wave in the recording leads to an ANA category result segment that contains the peak latency, total duration, peak duration (rise time), and amplitude of the sharp wave. During photic stimulation, each single light flash leads to an ANA category result segment that contains the onset latency of the detected flash signal (monitored in channel one). The beginning and end of each calibration sequence is indicated by STM category result segments. The beginning and end of each train of photic stimuli at a given frequency is indicated by STM category result segments.

C.3 These uses of the ANA and STM segment in a routine EEG are examples, which do not necessarily represent recommended usage. An alternative method of marking the time of occurrence of photic stimuli, which does not require the use of a separate channel for a marker and does not require an ANA algorithm for detection, is to transmit a separate STM category result segment at the time of each light flash, instead of a **BEGIN** and **END** STM category result segment before and after each train of flashes.

C.4 The EEG example also illustrates the use of null category result segments to transmit individual characteristics of waveforms seen in the EEG, such as their abundance, amplitude, frequency, etc. In the example, these characteristics were obtained by visual inspection and not by computer processing. The use of null category result segments in EEG reporting is optional, but may be helpful in organizing data concerning EEGs for long-term storage (for example, in a database).

C.5 The motor and sensory nerve conduction studies and EMG examination example illustrates how, in a two-way message transmission system, a single OBR segment could have been transmitted to order generic *EMG studies* using a test/observation ID of 9586X. The laboratory system then generated three separate OBR segments (acting as result header segments) on returning the results, one each for test/observation ID 95900 (motor NCS), 95904 (sensory NCS), and 95860 (one extremity EMG with related paraspinals); fields from the originally transmitted OBR segment would be duplicated into each of the returned OBR segments. Although in this example each of these three studies has its own report and interpretation, it would also be possible to omit these from all but the last study and then transmit a comprehensive report and interpretation covering all three studies, using the generic test/observation ID 9586X to label the result segments containing the report.

C.6 The motor nerve conduction study example illustrates the use of STM category result segments to specify the electric stimuli used, and ANA category result segments to measure CMAP amplitudes and latencies; each ANA category result segment was generated in response to manually positioning a cursor over the CMAP. In this example, all stimulation trials are transmitted, whereas in practice it may be sufficient to transmit only the final trial (after the CMAP amplitude has plateaued) for each stimulation and recording site. The *final* results reported in result (OBX) segments without any information category code include only distal latency and proximal amplitude, as well as some calculated quantities such as conduction velocity; the proximal latency and distal amplitudes are not reported. This illustrates the principle that any number of measurements and annotations may be attached to the waveform data using ANA category result segments, while a laboratory need only report a small number of values of diagnostic significance (along with the associated normal ranges). The sensory nerve conduction study example uses STM and ANA category result segments for similar purposes; it also illustrates how averaged waveform data (from four consecutive stimuli) may be transmitted.

C.7 The EMG example illustrates how ANA category result segments can be used to transmit measured characteristics of multiple motor unit potentials (amplitudes, durations, firing frequencies, number of phases, and number of turns). Quantitative results of this type may be averaged and reported in result (OBX) segments without any information category code as the *final* results of the study, or, as in this example, only qualitative final results (grades of abnormality) may be reported for each muscle.

C.8 The VEP example illustrates the use of STM and ANA category result segments in defining EP stimulus parameters and in measuring peak amplitudes and latencies; each ANA category result segment was generated in response to manually positioning a cursor over one of the EP peaks in two of the recording channels and measuring latency and amplitude. The *final* results reported in result (OBX) segments without any information category code include some stimulus parameters, and latencies and morphologies for the N75, P100, and N145 peaks in only one of the channels; amplitude values are not reported. Although latencies for all three VEP peaks and for both normal and large check size are transmitted in this example, many laboratories would report fewer results (for example, only the left and right P100 latencies and the inter-eye difference for one check size).

C.9 In the example message transmission (Fig. C-1), **<CR>** indicates an ASCII carriage return character (ASCII 13). Also, for readability, the line length in this example is limited to about 60 characters, and any segments longer than this are continued in subsequent lines by using addenda (A) markers. In this example, individual components or subcomponents of fields are not split across line boundaries when possible. In actuality, only lines longer than 220 characters are required by this Technical Standard to be split, and segments may be split at any location, even within a component or subcomponent.

C.10 The following is a detailed explanation of each of the segments contained in the example message:

C.10.1 *Header (H) Segment*—Specifies the delimiters (**|^~\&**), a message control ID which uniquely identifies this message among all messages transmitted by this sender (19264), a security field or password (34X96ABE59YW), sender ID and name, address, and telephone number, message type (type code **ORU** indicating unsolicited observation result message and trigger event code **R01** indicating unsolicited transmission of requested observations; use of this field is entirely optional in an NCCLS LIS 5-A message), receiver ID and name, comment text (Example), processing ID (**P** = production), Technical Standard version (**E.3**), and date and time of transmission (March 24, 1990 at 10:12:15).

C.10.2 *Patient ID (P) Segment*—Contains a sequence number (1), requestor-assigned and producer-assigned patient ID numbers (both 4567890, with mod 10 check digit 1), alternative patient ID (Social Security Number 3-777-222), patient name (John Doe) and mother's maiden name (Deere), birth date (February 2, 1930), sex (**M**), race (**W**), address, daytime and nighttime telephone numbers, primary physician provider ID (UPIN) and name, height (160 cm), weight (60 kg), known diagnoses (using ICD-9-CM codes), current medications, dietary information, handedness (right), admission date (Feb 14, 1990), status (**IP** = inpatient), location or ward (Psych), religion (**C**), marital status (**M**), isolation status (**BP** = blood and needle precautions), language (English), confidentiality status (**PSY** = psychiatry patient), and registration date (Feb 14, 1990).

C.10.3 *Order (OBR) Segment*—Contains a sequence number (1), requestor-assigned accession number (5678^Neuro, indicating the 5678th order generated by the neurologic clinic computer system), producer-assigned accession number (1234^EEG, indicating the 1234th order processed by the EEG laboratory computer system), test/observation ID (95816 = routine EEG), date and time requested (March 23, 1990 at 09:52:16), date and time study began (March 24, 1990 at 08:12:16), date and time study ended (March 24, 1990 at 08:51:42), action code (**N** = new order), potential hazards to laboratory personnel (dementia), clinical information, ordering physician's ID, name, and telephone number, date and time results of study reported (March 24, 1990 at 10:10:17), producer charge (214.50 dollars), producer section (**EN** = electroneurophysiology), order status (**F** = final results), transportation mode (**WHLC** = wheelchair), principal physician interpreting study, assisting interpreter or resident, technician performing study, and report transcriptionist. The physicians' names are preceded by a provider ID number (assumed here to be a UPIN number), separated from the name by a component delimiter (^). The technician and transcriptionist names, hazards to laboratory personnel, and clinical information are also preceded by a component delimiter to allow a similar alphanumeric code to be given before the component delimiter if desired.

C.10.4 *DST Category Result (OBX) Segment*—Contains two distance measurements, the inion to nasion distance (36.5 cm) and the left-to-right preauricular point distance (37 cm).

C.10.5 *MTG Category Result (OBX) Segment*—

Defines montage number 1, montage name **LR-21.1 (A1/2)**, containing 21 data channels.

C.10.6 *ELC Category Result (OBX) Segment*—Defines actual electrodes 1 to 23 and derived electrode 24 associated with montage 1. The electrode location (origin of coordinate system), **T-Y0100** (center of head), and the electrode attributes (disks with paste, gold, 0.6 cm) are specified only for electrode number 1, but apply to all electrodes. An electrode number, name, and theta and phi angular coordinates are given for each actual electrode. The derived electrode, Av, is defined as the average of A1 and A2.

C.10.7 *CHN Category Result (OBX) Segment*—Defines the 21 data channels by number and specifies that all channels receive calibration signal inputs (**CAL**). The channel sensitivity (0.5 µV), minimum and maximum data values (-2048 to 2047), and filter settings (analog, passes 1 to 70 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. A default sensitivity correction factor of 1.0, a default channel baseline value of 0, and a default time skew of 0 are assumed for each channel (that is, all channels are sampled and digitized simultaneously, or sample-and-hold registers are employed making digitization effectively simultaneous). No sampling frequencies are specified.

C.10.8 *TIM Category Result (OBX) Segment*—Defines the start of the first epoch at a time 130 ms past 8:12:16 on March 24, 1990, as well as specifying the sampling interval (0.005 s) and transmitted data format (**DNC**, indicating waveform data with no channel numbers). The test/observation ID in field 4 of this and subsequent result segments is 95816.9100 rather than the generic 95816, to indicate square wave calibration data.

C.10.9 *STM Category Result (OBX) Segment*—Defines the beginning of a square-wave calibration signal repeating at 0.5 Hz, with 1-s duration of each phase (**ON** or **OFF**), and 50-µV amplitude.

C.10.10 *WAV Category Result (OBX) Segment*—Contains a pointer to the binary waveform data for the 21 channels at each time point during the first **ON** calibration pulse. The pointer references a file **P4567890.dat** starting at byte address 0, of length 8400 bytes (200 time points or 1 second), which contains data in the 16-bit signed integer format. The system and device on which the file is stored is assumed to be known by context.

C.10.11 *ANA Category Result (OBX) Segment*—Indicates a calibration routine (**CAL**) detected an **ON** signal in all channels. The calibration signal waveform for each channel was fit to an exponential decay curve, and the values of peak pulse amplitude (**PKAM**) in microvolts, channel baseline (**BASE**), and the low frequency filter cut-off (**LLF**) in hertz are given. The analysis algorithm and type code and the units and names associated with the three parameters are specified only for channel 1, but apply to all channels. The calculated amplitudes and frequencies are near the expected 50-µV calibration signal amplitude and 1-Hz low frequency filter setting.

C.10.12 *WAV Category Result (OBX) Segment*—Contains a pointer to the binary waveform data for the 21 channels at each time point during the first **OFF** calibration pulse. The pointer references data in the 16-bit signed integer format starting at byte address 8400, of length 8400 bytes (200 time points or 1 second). The system, device, and file name for this data are assumed to be the same as in the last WAV category result segment and are therefore omitted.

C.10.13 *ANA Category Result (OBX) Segment*—Indicates a calibration routine (**CAL**) detected an **OFF** signal in all channels. The calibration signal waveform for each channel was fit to an exponential decay curve, and the values of peak pulse amplitude (**PKAM**) in microvolts, channel baseline (**BASE**), and the low-frequency filter cut-off (**LLF**) in hertz are given. Subsequent WAV and ANA segments occur at this point as a result of subsequent calibration pulses.

C.10.14 *STM Category Result (OBX) Segment*—Defines the end of the calibration signal repeating at 0.5 Hz, with 1-s duration of each phase, and 50-µV amplitude.

C.10.15 *CHN Category Result (OBX) Segment*—Defines the 21 data channels for biocalibration by number and first and second electrode inputs (all use Fp1 as the first input and O2 as the second input). The channel sensitivity (0.5 µV), minimum and maximum data values (-2048 to 2047), and filter settings (analog, passes 1 to 70 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. The sensitivity correction factors and channel baseline values derived from the average of the analyses of square-wave calibration data are given for each channel individually. Time skews for all channels are assumed to be zero. No sampling frequencies are specified. The test/observation ID in field 4 of this segment is 95816 rather than 95816.9301, since a channel change applies to all subsequent portions of the recording.

C.10.16 *TIM Category Result (OBX) Segment*—Defines the start of the second epoch at a time 815 ms past 8:12:26 on March 24, 1990, as well as specifying the sampling interval (0.005 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95816.9301 to indicate biocalibration data while awake with eyes closed.

C.10.17 *ANA Category Result (OBX) Segments*—Contain the annotations *begin biocal* (**BBIO**), *awake* (**AWAK**), and *eyes closed* (**ECLO**); the first of these is a machine-generated annotation (**MACH**), while the other two are manually generated (**MAN**).

C.10.18 *WAV Category Result (OBX) Segment*—Contains a pointer to the binary waveform data containing 1600 time points (8 seconds) for the 21 channels during the biocalibration.

C.10.19 *CHN Category Result (OBX) Segment*—Defines the 21 data channels for routine recording by number and first and second electrode inputs (all use Av as the second input). The channel sensitivity (0.5 μV), minimum and maximum data values (-2048 to 2047), and filter settings (analog, passes 1 to 70 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. The sensitivity correction factors and channel baseline values are given for each channel individually; time skews are assumed to be zero. No sampling frequencies are specified.

C.10.20 *TIM Category Result (OBX) Segment*—Defines the start of the third epoch at a time 525 ms past 8:12:37 on March 24, 1990, as well as specifying the sampling interval (0.005 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95816.0101 to indicate standard conditions while awake with eyes closed.

C.10.21 *ANA Category Result (OBX) Segments*—Contain the annotations *awake* (**AWAK**) and *eyes closed* (**ECLO**); both of these are manually generated (**MAN**).

C.10.22 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of binary waveform data containing 2000 time points (10 seconds) for the 21 channels. Other WAV category result segments follow that contain pointers to additional blocks of binary waveform data.

C.10.23 *CHN Category Result (OBX) Segment*—Redefines the 21 data channels by number and electrode inputs; the sensitivity of 0.5 μV, minimum and maximum data values (-2048 and 2047), and new filter settings (analog, passes 1 to 15 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. The sensitivity correction factors and channel baseline values derived from calibration data are again given for each channel individually; time skews are assumed to be zero. No sampling frequencies are specified.

C.10.24 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of additional binary waveform data containing 2000 time points (10 seconds) for the 21 channels. Other WAV category result segments follow at this point that contain pointers to additional blocks of binary waveform data.

C.10.25 *ANA Category Result (OBX) Segment*—Indicates a computer (**AUTO**) detected sharp wave (**SHW**) in channels 1, 2, 3, 5, 7, 11, 17, 18, and 19 at peak latency (**PKLA**) 142.355 s after the start of the epoch which began at 08:12:37 plus 525 ms on March 24, 1990. The total durations (**TODR**) and peak durations or rise times (**PKDR**) in units of the sampling interval (0.005 s), and the peak-to-peak amplitudes (**PKAM**) in units of channel sensitivity (0.5 μV) of the sharp wave in each channel are included. The analysis algorithm and type code and the units and names associated with the four parameters are specified only for channel 1, but apply to all channels.

C.10.26 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of binary waveform data containing one additional time point.

C.10.27 *ANA Category Result (OBX) Segment*—Indicates a computer (**AUTO**) detected sharp wave (**SHW**) in channels 4, 6, 8, 9, 10, 12, 13, 14, 15, 16, 20, and 21 at peak latency (**PKLA**) 142.360 seconds after the start of the epoch which began at 08:12:37 plus 525 ms on March 24, 1990 (that is, one sampling interval after the last ANA category result segment). The total durations (**TODR**), peak durations (**PKDR**), and peak-to-peak amplitudes (**PKAM**) of the sharp wave in each channel are included. The analysis algorithm and type code and the units and names associated with the four parameters are specified only for channel 4, but apply to all channels.

C.10.28 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of binary waveform data containing one additional time point.

C.10.29 *ANA Category Result (OBX) Segment*—Contains an annotation, *jerk*, which is manually generated (**MAN**), indicating an observed myoclonic jerk.

C.10.30 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of additional binary waveform data containing 2000 time points (10 seconds). Further result (OBX) segments of categories WAV and ANA also occur at this point that contain pointers to additional blocks of binary waveform data.

C.10.31 *TIM Category Result (OBX) Segment*—Defines the start of a new epoch at time 315 ms past 8:25:38 on March 24, 1990. This segment was transmitted because the EEG recording had been temporarily suspended while instructions for hyper-ventilation were being given and to indicate (by means of a test/observation ID code in field 4 of 95816.2101) the beginning of the hyperventilation section of the recording.

C.10.32 *ANA Category Result (OBX) Segments*—Contain the annotations *begin HV* (**BGHV**), *awake* (**AWAK**), and *eyes closed* (**ECLO**); all of these are manually generated (**MAN**).

C.10.33 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of additional binary waveform data containing 2000 time points (10 seconds). Further result (OBX) segments of categories WAV and ANA also occur at this point as the hyperventilation recording continues.

C.10.34 *ELC Category Result (OBX) Segment*—Defines a new electrode number 25 in montage one, with the name *Strobe* and type **FLS** (flash signal monitor).

C.10.35 *CHN Category Result (OBX) Segment*—Redefines the 21 data channels by number and electrode inputs. Channel 1 input 1 is connected to electrode *Strobe*, while input 2 is not specified; the other channels are defined as before. The sensitivity of 0.5 µV, minimum and maximum data values (-2048 and 2047), and filter settings (analog, passes 1 to 15 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. The sensitivity correction factors and channel baseline values derived from calibration data are again given for each channel individually; time skews are assumed to be zero. No sampling frequencies are specified.

C.10.36 *TIM Category Result (OBX) Segment*—Defines the start of a new epoch at time 620 ms past 8:40:48 on March 24, 1990. The test/observation ID at this point changes to 95816.3101 indicating photic stimulation while awake with eyes closed.

C.10.37 *ANA Category Result (OBX) Segments*—Contain the annotations *begin photic* (**BPHO**), *awake* (**AWAK**), and *eyes closed* (**ECLO**); the first of these is a machine-generated annotation (**MACH**), while the other two are manually generated (**MAN**).

C.10.38 *STM Category Result (OBX) Segment*—Defines the start of photic stimulation (**FLS**) applied to the eyes bilaterally (**T-XX000-BIL**) at a frequency of 1 Hz, with duration 10 µs, and intensity 22 Candela-s/m^2 (white light).

C.10.39 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of binary waveform data containing 10 additional time points (50 ms).

C.10.40 *ANA Category Result (OBX) Segment*—Indicates a computer (**AUTO**) detection of a flash signal (**FLS**) in channel 1 (the flash signal monitor channel), 1.215 s (**ONLA**) after the start of the epoch which began at 08:40:48 plus 620 ms on March 24, 1990.

C.10.41 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of additional binary waveform data containing 200 time points (1 second). Further WAV, STM, and ANA category result (OBX) segments occur at this point (including one STM category result segment to define the start and end of each train of flash stimuli, and one ANA category result segment for each individual strobe detected).

C.10.42 *CHN Category Result (OBX) Segment*—Defines the 21 data channels by number and specifies that all channels receive calibration signal inputs (**CAL**). The channel sensitivity (0.5 µV), minimum and maximum data values (-2048 to 2047), and filter settings (analog, passes 1 to 70 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. A default sensitivity correction factor of 1.0, a default channel baseline value of 0, and a default time skew of 0 are assumed for each channel. No sampling frequencies are specified.

C.10.43 *TIM Category Result (OBX) Segment*—Defines the start of a new epoch at a time 670 ms past 8:51:20 on March 24, 1990. The test/observation ID in field 4 of this and subsequent result segments is 95816.9100 to indicate square wave calibration data.

C.10.44 *STM Category Result (OBX) Segment*—Defines the beginning of a square-wave calibration signal repeating at 0.5 Hz, with 1-s duration of each phase (**ON** or **OFF**), and 50-µV amplitude.

C.10.45 *WAV Category Result (OBX) Segment*—Contains a pointer to a block of binary waveform data for the 21 channels at each time point during the first **ON** calibration pulse. The data block has a length of 8400 bytes (200 time points or 1 second).

C.10.46 *ANA Category Result (OBX) Segment*—Indicates a calibration routine (**CAL**) detected an **ON** signal in all channels. The calibration signal waveform for each channel was fit to an exponential decay curve, and the values of peak pulse amplitude (**PKAM**) in microvolts, channel baseline (**BASE**), and low-frequency filter cut-off (**LLF**) in hertz are given. The analysis algorithm and type code and the units and names associated with the two parameters are specified only for channel 1, but apply to all channels.

C.10.47 *WAV Category Result (OBX) Segment*—Contains a pointer to the binary waveform data for the 21 channels at each time point during the first **OFF** calibration pulse. The data block has a length of 8400 bytes (200 time points or 1 second).

C.10.48 *ANA Category Result (OBX) Segment*—Indicates a calibration routine (**CAL**) detected an **OFF** signal in all channels. The values of peak pulse amplitude (**PKAM**) in microvolts, channel baseline (**BASE**), and low-frequency filter cut-off (**LLF**) in hertz are given for each channel. Subsequent WAV and ANA category result segments occur at this point as a result of subsequent calibration pulses.

C.10.49 *STM Category Result (OBX) Segment*—Defines the end of the calibration signal repeating at 0.5 Hz, with 1-s duration of each phase, and 50-μV amplitude.

C.10.50 *CHN Category Result (OBX) Segment*—Redefines the 21 data channels by number and specifies that all channels receive calibration signal inputs (**CAL**). The channel settings are the same except for the filter (analog, passes 1 to 15 Hz with 6-dB/octave rolloff).

C.10.51 *TIM Category Result (OBX) Segment*—Defines the start of a new epoch at a time 925 ms past 8:51:30 on March 24, 1990.

C.10.52 *STM Category Result (OBX) Segment*—Defines the beginning of a square-wave calibration signal repeating at 0.5 Hz, with 1-s duration of each phase (**ON** or **OFF**), and 50-μV amplitude.

C.10.53 *WAV Category Result (OBX) Segment*—Contains a pointer to the binary waveform data for the 21 channels at each time point during the first **ON** calibration pulse. The data block has a length of 8400 bytes (200 time points or 1 second).

C.10.54 *ANA Category Result (OBX) Segment*—Indicates a calibration routine (**CAL**) detected an **ON** signal in all channels. The values of peak pulse amplitude (**PKAM**) in microvolts, channel baseline (**BASE**), and low-frequency filter cut-off (**LLF**) in hertz are given.

C.10.55 *WAV Category Result (OBX) Segment*—Contains a pointer to the binary waveform data for the 21 channels at each time point during the first **OFF** calibration pulse. The data block has a length of 8400 bytes (200 time points or 1 second).

C.10.56 *ANA Category Result (OBX) Segment*—Indicates a calibration routine (**CAL**) detected an **OFF** signal in all channels. The values of peak pulse amplitude (**PKAM**), channel baseline (**BASE**), and low-frequency filter cut-off (**LLF**) are given. Subsequent WAV and ANA category result segments occur next as a result of further calibration pulses.

C.10.57 *STM Category Result (OBX) Segment*—Defines the end of the calibration signal repeating at 0.5 Hz, with 1-s duration of each phase, and 50-μV amplitude.

C.10.58 *Null Category Result (OBX) Segments*—First define the abundance (100%), amplitude (15 μV), frequency (5 Hz), asymmetry (symmetric), reactivity (slightly reactive), and distribution (generalized) of the theta activity in the background; then define the abundance (70%), amplitude (100 μV), frequency (1.5 Hz), duration (0.2 s), asymmetry (symmetric), and distribution (generalized, maximal anterior head region) of the periodic sharp waves in the recording. These values are derived from visual inspection of the EEG.

C.10.59 *GDT Category Result (OBX) Segment*—Contains the EEG descriptive report (two paragraphs).

C.10.60 *MDT Category Result (OBX) Segment*—Contains the EEG interpretation (two paragraphs).

C.10.61 *DEV Category Result (OBX) Segment*—Identifies the device used for the recording as a text description (with no preceding alphanumeric code).

C.10.62 *SER Category Result (OBX) Segment*—Identifies the serial number of the device used for the recording.

C.10.63 *CNP Category Result (OBX) Segments*—Contain the special procedures performed during the recording (95816.2100 = hyperventilation, 95816.3100 = photic stimulation).

C.10.64 *ANT and IMP Category Result (OBX) Segments*—Contain the diagnostic impressions for the study and their localizations using the **AS4** diagnosis and distribution coding systems (**AS4&EEGD** and **AS4&DIST**). The EEG localizations and impressions are *Generalized, maximal anterior head region: Very frequent periodic sharp waves* and *Generalized: Continuous low-amplitude theta activity*; these diagnoses are flagged by the **A** (abnormal) and **W** (worse) flags. The diagnoses for hyperventilation (95816.2100) and photic stimulation (95816.3100) are *No activation*.

C.10.65 *REC Category Result (OBX) Segment*—States a recommendation for a follow-up study (95816 = routine EEG recording) in 30 days.

C.10.66 *Patient ID (P) Segment*—Contains a sequence number (2), requestor- and producer-assigned patient ID numbers (both 3321123 with mod 10 check digit 6), subject name, birth date (August 10, 1953), sex (**M**), race (**W**), address, daytime and nighttime telephone numbers, primary physician ID number (UPIN) and name, height (153 cm), weight (74 kg), hand and foot dominance (both right), status (**OP** = outpatient), location or registration (Neuro), marital status (**M**), and registration date (March 20, 1990).

C.10.67 *Order (OBR) Segment*—Contains a sequence number (1), requestor-assigned accession number (5692^Neuro, indicating the 5692nd order generated by the neurologic clinic computer system), producer-assigned accession number (2314^EMG, indicating the 2314th order processed by the EMG laboratory computer system), test/observation ID (95900 = motor nerve conduction study), date and time requested (March 23, 1990 at 15:16:49), date and time study began (March 24, 1990 at 08:30:12), date and time study ended (March 24, 1990 at 08:41:28), action code (**N** = new order), clinical information, ordering physician's ID, name, and telephone number, date and time results of study reported (March 24, 1990 at 10:11:18), producer section (**EN** = electroneurophysiology), order status (**F** = final results), principal physician performing study, assisting physician or resident, technician assisting with study, and report transcriptionist. The physicians' names are preceded by a provider ID number, separated from the name by a component delimiter (^). The technician and transcriptionist names and the clinical information are also preceded by a component delimiter in order to allow a similar alphanumeric code to be given before the component delimiter if desired.

C.10.68 *MTG Category Result (OBX) Segment*—Defines montage number 1, containing one data channel.

C.10.69 *ELC Category Result (OBX) Segment*—Defines two actual electrodes, G1 and G2. Both electrode locations (belly and insertion of abductor pollicis brevis muscle) are given, and the electrode attributes (disks held with tape, tin, 0.4 cm) are specified only for electrode G1, but apply to G2 as well.

C.10.70 *CHN Category Result (OBX) Segment*—Defines the single data channel by number and first and second electrode inputs (G1 and G2). The channel sensitivity (5.0 µV), minimum and maximum values (-2048 to 2047), and filter settings (analog, passes 1 to 7000 Hz with 6-dB/octave rolloff) are specified. The default sensitivity correction factor (1.0), channel baseline value (0), and time skew (0) are assumed. No sampling frequency is specified.

C.10.71 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 710.5 ms past 8:30:22 on March 24, 1990, as well as specifying the sampling interval (0.0001 s) and the epoch length (0.040 s) and transmitted data format (**DNC**). Averaging is not used for this epoch. The test/observation ID in field 4 of this and subsequent result segments is 95900.288290001 rather than the generic 95900, to indicate that this portion of the study involves electric stimulation at the wrist recording from the right abductor pollicis brevis muscle, and that this is the first trial for these stimulation and recording sites.

C.10.72 *STM Category Result (OBX) Segment*—Defines the first stimulus parameters: electric with cathode distal (**ECD**), right median nerve at wrist (**T-X9180-RGT-LC9**), duration 0.1 ms, intensity 10 mA.

C.10.73 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first epoch at each time point (total 400 points in the 40-ms epoch), separated by repeat delimiters (~); when the same value would occur more than once in a row, it need not be repeated.

C.10.74 *TIM Category Result (OBX) Segment*—Defines the start of the second data epoch at a time 123.0 ms past 8:30:25 on March 24, 1990, as well as the sampling interval and epoch length and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95900.288290002 to indicate that this is the second trial for the same stimulation and recording sites.

C.10.75 *STM Category Result (OBX) Segment*—Defines the second stimulus parameters, which are the same as before except for intensity 20 mA.

C.10.76 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the second epoch at each time point.

C.10.77 *TIM Category Result (OBX) Segment*—Defines the start of the third data epoch at a time 662.5 ms past 8:30:27 on March 24, 1990. The test/observation ID now is 95900.288290003 to indicate the third trial.

C.10.78 *STM Category Result (OBX) Segment*—Defines the third stimulus parameters, which are the same as before except for intensity 30 mA.

C.10.79 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the third epoch at each time point.

C.10.80 *TIM Category Result (OBX) Segment*—Defines the start of the fourth data epoch at a time 37.2 ms past 8:30:30 on March 24, 1990. The test/observation ID now is 95900.288290004 to indicate the fourth trial.

C.10.81 *STM Category Result (OBX) Segment*—Defines the fourth stimulus parameters, which are the same as before except for intensity 40 mA.

C.10.82 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the fourth epoch at each time point. The CMAP here is unchanged from that at the last stimulus intensity (trial 3).

C.10.83 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked CMAP in channel 1 with onset latency (**ONLA**) 4.07 ms after the stimulus (which occurred at the start of the epoch which began at 08:30:30 plus 37.2 ms on March 24, 1990). The amplitude (**PKAM**) of the CMAP is 5.33 mV.

C.10.84 *TIM Category Result (OBX) Segment*—

Defines the start of the first data epoch at a time 710.5 ms past 8:31:22 on March 24, 1990, as well as specifying the sampling interval (0.0001 s) and the epoch length (0.040 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95900.288260001, to indicate that this portion of the study involves electric stimulation above the elbow recording from the right abductor pollicis brevis muscle, and that this is the first trial for these stimulation and recording sites.

C.10.85 *STM Category Result (OBX) Segment*—Defines the first stimulus parameters: electric with cathode distal (**ECD**), right median nerve above elbow (**T-X9180-RGT-LC6**), duration 0.1 ms, intensity 10 mA.

C.10.86 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first epoch at each time point.

C.10.87 *TIM Category Result (OBX) Segment*—Defines the start of the second data epoch at a time 215.8 ms past 8:31:25 on March 24, 1990. The test/observation ID in field 4 of this and subsequent result segments is 95900.288260002 to indicate that this is the second trial for the same stimulation and recording sites.

C.10.88 *STM Category Result (OBX) Segment*—Defines the second stimulus parameters, which are the same as before except for intensity 20 mA.

C.10.89 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the second epoch at each time point.

C.10.90 *TIM Category Result (OBX) Segment*—Defines the start of the third data epoch at a time 846.2 ms past 8:31:27 on March 24, 1990. The test/observation ID now is 95900.288260003 to indicate the third trial.

C.10.91 *STM Category Result (OBX) Segment*—Defines the third stimulus parameters, which are the same as before except for intensity 30 mA.

C.10.92 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the third epoch at each time point.

C.10.93 *TIM Category Result (OBX) Segment*—Defines the start of the fourth data epoch at a time 187.3 ms past 8:31:30 on March 24, 1990. The test/observation ID now is 95900.288260004 to indicate the fourth trial.

C.10.94 *STM Category Result (OBX) Segment*—Defines the fourth stimulus parameters, which are the same as before except for intensity 40 mA.

C.10.95 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the fourth epoch at each time point. The CMAP here is unchanged from that at the last stimulus intensity (trial 3).

C.10.96 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked CMAP in channel 1 with onset latency (**ONLA**) 9.92 ms after the stimulus (which occurred at the start of the epoch which began at 08:31:30 plus 187.3 ms on March 24, 1990). The amplitude (**PKAM**) of the CMAP is 5.21 mV.

C.10.97 *DST Category Result (OBX) Segment*—Contains the measured distance between the two stimulation sites along the right median nerve (wrist to elbow, 30.4 cm). The test/observation ID in this segment is 95900, since the distance value is not applicable to a single trial or site.

C.10.98 *ELC Category Result (OBX) Segment*—Redefines two actual electrodes, G1 and G2. Both electrode locations (belly and insertion of abductor digiti minimi muscle) are given, and the electrode attributes (disks held with tape, tin, 0.4 cm) are specified only for electrode G1, but apply to G2 as well. The CHN category result segment previously given remains in effect.

C.10.99 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 710.5 ms past 8:34:22 on March 24, 1990, as well as specifying the sampling interval (0.0001 s) and the epoch length (0.040 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95900.294090001, to indicate that this portion of the study involves electric stimulation at the wrist recording from the right abductor digiti minimi muscle, and that this is the first trial for these stimulation and recording sites.

C.10.100 *STM Category Result (OBX) Segment*—Defines the first stimulus parameters: electric with cathode distal (**ECD**), right ulnar nerve at wrist (**T-X9170-RGT-LC9**), duration 0.1 ms, intensity 10 mA.

C.10.101 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first epoch at each time point. Other TIM, STM, and WAV category result segments follow at this point for three other trials at this stimulation site.

C.10.102 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked CMAP in channel 1 with onset latency (**ONLA**) 3.41 ms after the stimulus (which occurred at the start of the epoch which began at 08:34:22 plus 710.5 ms on March 24, 1990). The amplitude (**PKAM**) of the CMAP is 10.81 mV.

C.10.103 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 836.2 ms past 8:35:02 on March 24, 1990. The test/observation ID in field 4 of this and subsequent result segments is 95900.294060001, to indicate that this portion of the study involves electric stimulation above the elbow recording from the right abductor digiti minimi muscle, and that this is the first trial for these stimulation and recording sites.

C.10.104 *STM Category Result (OBX) Segment*—Defines the first stimulus parameters: electric with cathode distal (**ECD**), right ulnar nerve above elbow (**T-X9170-RGT-LC6**), duration 0.1 ms, intensity 10 mA.

C.10.105 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first epoch at each time point. Other TIM, STM, and WAV category result segments follow at this point for four other trials at this stimulation site.

C.10.106 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked CMAP in channel 1 with onset latency (**ONLA**) 9.72 ms after the stimulus (which occurred at the start of the epoch which began at 08:35:02 plus 836.2 ms on March 24, 1990). The amplitude (**PKAM**) of the CMAP is 10.32 mV.

C.10.107 *DST Category Result (OBX) Segment*—Contains the measured distance between the two stimulation sites along the right ulnar nerve (wrist to elbow, 32.5 cm). The test/observation ID in this segment is 95900, since the distance value is not applicable to a single trial or site.

C.10.108 *Null Category Result (OBX) Segments*—Each of the result segments with no information category code contains one numeric (NM) or coded (CE) value to be reported to the ordering physician. The method of body temperature measurement, temperature value, units, normal range, and normalcy status flag (**N** = normal), and the temperature measurement location (over the right first dorsal interosseous muscle) are first reported. The CMAP amplitude for the proximal stimulation site, conduction velocity from the proximal to distal sites, ratio of CMAP amplitudes for the proximal to distal sites, and the CMAP latency for the distal site are reported for both the median and ulnar nerves, and the median-ulnar distal latency difference (and its opposite, the ulnar-median distal latency difference) are also reported. The units and normal ranges are also reported, as well as a normalcy status flag (**N** = normal).

C.10.109 *GDT Category Result (OBX) Segment*—Contains the motor nerve conduction study descriptive report.

C.10.110 *MDT Category Result (OBX) Segment*—Contains the motor nerve conduction study interpretation.

C.10.111 *DEV Category Result (OBX) Segment*—Identifies the device used for the study as a text description only.

C.10.112 *SER Category Result (OBX) Segment*—Identifies the serial number of the device used for the study.

C.10.113 *ANT and IMP Category Result (OBX) Segments*—Contain the diagnostic impression for the study (*Normal*) and its localization (*Right ulnar nerve* and *Right median nerve*) using the **AS4** diagnosis coding system (**AS4&MNCD**) and SNOMED topographic localization codes (**SNM+&TOPO**), respectively.

C.10.114 *Order (OBR) Segment*—Contains a sequence number (2), requestor-assigned accession number (5692^Neuro, the same as in the previous OBR segment), producer-assigned accession number (2315^EMG, indicating the 2315th order processed by the EMG laboratory computer system), test/observation ID (95904 = sensory nerve conduction study), date and time requested (March 23, 1990 at 15:16:49), date and time study began (March 24, 1990 at 08:42:12), date and time study ended (March 24, 1990 at 08:47:54), action code (**G** = generated order), clinical information, ordering physician's ID, name, and telephone number, date and time results of study reported (March 24, 1990 at 10:11:20), producer section (**EN** = electroneuro-physiology), order status (**F** = final results), parent order requestor-assigned accession number (5692&Neuro) and producer-assigned accession number (2314&EMG) to link this segment to the parent order (that is, the first order), principal physician performing study, assisting physician or resident, technician assisting with study, and report transcriptionist. The physicians' names are preceded by a provider ID number, separated from the name by a component delimiter (^). The technician and transcriptionist names and the clinical information are also preceded by a component delimiter in order to allow a similar alphanumeric code to be given before the component delimiter if desired.

C.10.115 *MTG Category Result (OBX) Segment*—Defines montage number 1, containing two data channels.

C.10.116 *ELC Category Result (OBX) Segment*—Defines four actual electrodes, G1 to G4. Their locations (right median nerve at wrist for G1 and G2, right median nerve above elbow for G3 and G4) are given, and the electrode attributes (electrodes held with tape, tin, 0.4 cm for G1 and G2; electrodes mounted in a strip, tin, 0.5 cm for G3 and G4) are specified as well. Coordinates along a proximal-distal (**PD**) axis (0 and -3.5 cm) for each electrode pair are also given, indicating that the electrodes in each pair are 3.5 cm apart.

C.10.117 *CHN Category Result (OBX) Segment*—Defines the two data channels by number and first and second electrode inputs. The channel sensitivity (0.5 µV), minimum and maximum values (-2048 to 2047), and filter settings (analog, passes 32 to 3200 Hz with 6-dB/octave rolloff) are specified for the first channel only, but apply to the second channel as well. The default sensitivity correction factor (1.0), channel baseline value (0), and time skew (0) are assumed for both channels. No sampling frequencies are specified.

C.10.118 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 483.7 ms past 8:42:18 on March 24, 1990, as well as specifying the sampling interval (0.0001 s) and the epoch length (0.040 s) and transmitted data format (**DNC**). Averaging is not used for this epoch. The test/observation ID in field 4 of this and subsequent result segments is 95904.218500001 rather than the generic 95904, to indicate that this portion of the study involves electric stimulation of the right median nerve at the palm; a recording site is not specified in the test/observation ID, since recording from both wrist and elbow is done simultaneously. The test/observation ID also indicates that this is the first trial for this stimulation site.

C.10.119 *STM Category Result (OBX) Segment*—Defines the first stimulus parameters: electric with cathode proximal (**ECP**), right median nerve palmar branch (**T-X9185-RGT**), duration 0.1 ms, intensity 10 mA.

C.10.120 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first epoch for two channels at each time point (total 400 time points in the 40 ms epoch). At the first time point, values for both channel 1 (1) and channel 2 (0) are given; at subsequent time points, the value for channel 2 does not change and is not present (first three lines showing stimulus artifact and response at wrist), then the response for channel 1 does not change and is not present, although a component delimiter (^) is necessary to mark its place (fourth and fifth lines showing response at elbow). Additional TIM, STM, and WAV segments occur next defining two additional stimulus trials (epochs) before a plateau in the SNAP amplitude is reached.

C.10.121 *TIM Category Result (OBX) Segment*—Defines the start of the fourth data epoch at a time 657.1 ms past 8:42:31 on March 24, 1990, as well as the sampling interval and epoch length and transmitted data format (**DNC**); this epoch is defined as containing averaged data for four separate stimuli (including **ALL** stimuli in the average, and with the epoch for averaging beginning at the time of the stimulus). The test/observation ID now is 95904.218500004 to indicate that these four stimuli and responses averaged together represent the fourth trial for this stimulation site.

C.10.122 *STM Category Result (OBX) Segment*—Defines the fourth (and subsequent) stimulus parameters, which are the same as before except for intensity 30 mA; **BEGIN** indicates that a train of stimuli with a repetition rate of 0.5 Hz is used (because four data samples are averaged in this trial).

C.10.123 *WAV Category Result (OBX) Segment*—Contains the averaged digital waveform data for the fourth epoch at each time point.

C.10.124 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked SNAP in channels 1 and 2 with onset latencies (**ONLA**) of 1.80 ms and 6.95 ms, respectively, after the stimulus (which occurred at the start of the epoch which began at 08:42:31 plus 657.1 ms on March 24, 1990). The amplitudes (**PKAM**) of the SNAP in channels 1 and 2 are 160 µV and 80 µV. The peak latency (**PKLA**) of the SNAP in channel 1 (but not channel 2) is also recorded (2.16 ms).

C.10.125 *DST Category Result (OBX) Segment*—Contains the measured distance between the two recording sites along the right median nerve (wrist to elbow, 30.2 cm). The test/observation ID in this segment is 95904, since the distance value is not applicable to a single trial or site.

C.10.126 *ELC Category Result (OBX) Segment*—Redefines four actual electrodes, G1 to G4. Their locations (right ulnar nerve at wrist for G1 and G2, right ulnar nerve above elbow for G3 and G4) are given, and the electrode attributes (electrodes held with tape, tin, 0.4 cm for G1 and G2, electrodes mounted in a strip, tin, 0.5 cm for G3 and G4) are specified as well. Coordinates along a proximal-distal (**PD**) axis (0 and -3.5 cm) for each electrode pair are also given, indicating that the electrodes in the strip are 3.5 cm apart. The CHN category result segment previously given remains in effect.

C.10.127 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 372.8 ms past 8:43:57 on March 24, 1990, as well as specifying the sampling interval (0.0001 s) and the epoch length (0.040 s) and transmitted data format (**DNC**). Averaging is not used for this epoch. The test/observation ID in field 4 of this and subsequent result segments is 95904.217400001 to indicate that this portion of the study involves electric stimulation of the right ulnar nerve at the palm; a recording site is not specified in the test/observation ID, since recording from both wrist and elbow is done simultaneously. The test/observation ID also indicates that this is the first trial for this stimulation site.

C.10.128 *STM Category Result (OBX) Segment*—Defines the first stimulus parameters: electric with cathode proximal (**ECP**), right ulnar nerve palmar branch (**T-X9174-RGT**), duration 0.1 ms, intensity 10 mA.

C.10.129 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first epoch for two channels at each time point (total 400 time points in the 40-ms epoch). At the first time point, values for both channel 1 (1) and channel 2 (0) are given; at subsequent time points, the value for channel 2 does not change and is not present (first three lines showing stimulus artifact and response at wrist), then the response for channel 1 does not change and is not present, although a component delimiter (^) is necessary to mark its place (fourth and fifth lines showing response at elbow). Additional TIM, STM, and WAV segments occur next defining three additional stimulus trials (epochs) until a plateau in the SNAP amplitude is reached.

C.10.130 *TIM Category Result (OBX) Segment*—Defines the start of the fifth data epoch at a time 936.2 ms past 8:44:10 on March 24, 1990, as well as the sampling interval and epoch length and transmitted data format (**DNC**); this epoch is defined as containing averaged data for four separate stimuli (including **ALL** stimuli in the average, and with the epoch for averaging beginning at the time of the stimulus). The test/observation ID now is 95904.217400005 to indicate that these four stimuli and responses averaged together represent the fifth trial for this stimulation site.

C.10.131 *STM Category Result (OBX) Segment*—Defines the fifth (and subsequent) stimulus parameters, which are the same as before except for intensity 40 mA; **BEGIN** indicates that a train of stimuli with a repetition rate of 0.5 Hz are used (because four data samples are averaged in this trial).

C.10.132 *WAV Category Result (OBX) Segment*—Contains the averaged digital waveform data for the fifth epoch at each time point.

C.10.133 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked SNAP in channels 1 and 2 with onset latencies (**ONLA**) of 1.60 ms and 6.93 ms, respectively, after the stimulus (which occurred at the start of the epoch which began at 08:44:10 plus 936.2 ms on March 24, 1990). The amplitudes (**PKAM**) of the SNAP in channels 1 and 2 are 140 µV and 70 µV. The peak latency (**PKLA**) of the SNAP in channel 1 (but not channel 2) is also recorded (1.92 ms).

C.10.134 *DST Category Result (OBX) Segment*—Contains the measured distance between the two recording sites along the right ulnar nerve (wrist to elbow, 32.8 cm). The test/observation ID in this segment is 95904, since the distance value is not applicable to a single trial or site.

C.10.135 *Null Category Result (OBX) Segments*—Each of the result segments with no information category code contains one numeric (NM) or coded (CE) value to be reported to the ordering physician. The method of body temperature measurement, temperature value, units, normal range, and normalcy status flag (**N** = normal), and the temperature measurement location (over the right first dorsal interosseous muscle) are first reported. The conduction velocity from the proximal to distal recording sites, ratio of SNAP amplitudes for the proximal to distal sites, the SNAP amplitude at the distal site, and the SNAP peak latency for the distal site are reported for both the median and ulnar nerves, and the median-ulnar distal latency difference (and its opposite, the ulnar-median distal latency difference) are also reported. The units and normal ranges are also reported, as well as a normalcy status flag (**N** = normal, **H** = high).

C.10.136 *GDT Category Result (OBX) Segment*—Contains the sensory nerve conduction study descriptive report.

C.10.137 *MDT Category Result (OBX) Segment*—Contains the sensory nerve conduction study interpretation.

C.10.138 *DEV Category Result (OBX) Segment*—Identifies the device used for the study as a text description only.

C.10.139 *SER Category Result (OBX) Segment*—Identifies the serial number of the device used for the study.

C.10.140 *ANT and IMP Category Result (OBX) Segments*—Contain the diagnostic impression for the study (*Mildly increased SNAP ipsilateral reference nerve latency difference*) and its localization (*Right distal forearm/leg portion median nerve*) using **AS4** diagnosis codes (**AS4&SNCD**) and SNOMED topographic location codes (**SNM+&TOPO**), respectively. A second IMP category result segment contains a clinical diagnosis using ICD-9-CM codes (*carpal tunnel syndrome*). These IMP category result segments also contain the status flag **A**, abnormal.

C.10.141 *Order (OBR) Segment*—Contains a sequence number (3), requestor-assigned accession number (5692^Neuro, the same as in the previous two OBR segments), producer-assigned accession number (2316^EMG, indicating the 2316th order processed by the EMG laboratory computer system), test/observation ID (95860 = one extremity EMG with related paraspinals), date and time requested (March 23, 1990 at 15:16:49), date and time study began (March 24, 1990 at 08:50:08), date and time study ended (March 24, 1990 at 09:05:48), action code (**G** = generated order), clinical information, ordering physician's ID, name, and telephone number, date and time results of study reported (March 24, 1990 at 10:11:22), producer section (**EN** = electroneurophysiology), order status (**F** = final results), parent order requestor-assigned accession number (5692&Neuro) and producer-assigned accession number (2314&EMG) to link this segment to the parent order (that is, the first order), principal physician performing study, assisting physician or resident, technician assisting with study, and report transcriptionist. The physicians' names are preceded by a provider ID number, separated from the name by a component delimiter (^). The technician and transcriptionist names and the clinical information are also preceded by a component delimiter in order to allow a similar alphanumeric code to be given before the component delimiter if desired.

C.10.142 *MTG Category Result (OBX) Segment*—Defines montage number 1, containing one data channel.

C.10.143 *ELC Category Result (OBX) Segment*—Defines one actual electrode, NDL, with two elements. The electrode location (right abductor pollicis brevis muscle) and the electrode attributes for each of the two elements (concentric needle; platinum core, stainless steel shaft, diameters 0.025 and 0.05 cm, polarities 1 and -1) are specified as well.

C.10.144 *CHN Category Result (OBX) Segment*—Defines one data channel and a single electrode (NDL) input. The channel sensitivity (1.0 μV), minimum and maximum values (-2048 to 2047), and filter settings (analog, passes 32 to 16000 Hz with 6-dB/octave rolloff) are specified. The default sensitivity correction factor (1.0), channel baseline value (0), and time skew (0) are assumed. No sampling frequency is specified.

C.10.145 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 382.5 ms past 8:50:25 on March 24, 1990, as well as specifying the sampling interval (0.0005 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95860.28820001 rather than the generic 95860, to indicate that this portion of the study involves recording from the right abductor pollicis brevis muscle. The test/observation ID also indicates that this is the first sample for this recording site.

C.10.146 *ANA Category Result (OBX) Segment*—Contains the annotation *insertional activity sample*, which was generated by a physician review of the data (**PHYS**).

C.10.147 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first sample at each time point, separated by repeat delimiters (~).

C.10.148 *TIM Category Result (OBX) Segment*—Defines the start of the second data epoch at a time 463.0 ms past 8:50:29 on March 24, 1990, as well as specifying the sampling interval (0.0005 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95860.28820002 to indicate that this is the second sample for this recording site.

C.10.149 *ANA Category Result (OBX) Segment*—Contains the annotation *spontaneous activity sample*, which was generated by a physician review of the data (**PHYS**).

C.10.150 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the second sample at each time point, separated by repeat delimiters (~).

C.10.151 *TIM Category Result (OBX) Segment*—Defines the start of the third data epoch at a time 483.5 ms past 8:50:36 on March 24, 1990, as well as specifying the sampling interval (0.0005 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95860.28820003 to indicate that this is the third sample for this recording site.

C.10.152 *ANA Category Result (OBX) Segment*—Contains the annotation *voluntary activity sample*, which was generated by a physician review of the data (**PHYS**).

C.10.153 *WAV Category Result (OBX) Segment*—Contains some digital waveform data for the third sample at each time point, separated by repeat delimiters (~).

C.10.154 *ANA Category Result (OBX) Segment*—Indicates a physician (**PHYS**) marked motor unit potential (**MUP**) in channel 1 which was in an epoch which began at 08:50:36 plus 483.5 ms on March 24, 1990. The total duration (**TODR**), peak duration or rise time (**PKDR**), peak-to-peak amplitude (**PKAM**), firing frequency (**FRQ**), number of phases (**NPHASE**), and number of turns (**NTURN**) of the motor unit potential are given.

C.10.155 *WAV Category Result (OBX) Segment*—Contains more digital waveform data for the third sample at each time point.

C.10.156 *ANA Category Result (OBX) Segment*—Indicates another physician (**PHYS**) marked motor unit potential (**MUP**) in channel 1 which was in an epoch which began at 08:50:36 plus 483.5 ms on March 24, 1990. The total duration (**TODR**), peak duration or rise time (**PKDR**), peak-to-peak amplitude (**PKAM**), firing frequency (**FRQ**), number of phases (**NPHASE**), and number of turns (**NTURN**) of the motor unit potential are given.

C.10.157 *WAV Category Result (OBX) Segment*—Contains more digital waveform data for the third sample at each time point. Further WAV and ANA category result segments occur at this time, representing additional motor unit potentials.

C.10.158 *ELC Category Result (OBX) Segment*—Defines one actual electrode, NDL, with two elements as before, but with a location of the right first dorsal interosseous muscle of the hand. The test/observation ID in field 4 of this segment is a generic 95860 since the segment may apply to various samples. The last defined channel setting remains in effect.

C.10.159 *TIM Category Result (OBX) Segment*—Defines the start of the first data epoch at a time 382.0 ms past 8:51:19 on March 24, 1990, as well as specifying the sampling interval (0.0005 s) and transmitted data format (**DNC**). The test/observation ID in field 4 of this and subsequent result segments is 95860.29810001 rather than the generic 95860, to indicate that this portion of the study involves recording from the right dorsal interosseous muscle. The test/observation ID also indicates that this is the first sample for this recording site.

C.10.160 *ANA Category Result (OBX) Segment*—Contains the annotation *insertional activity sample*, which was generated by a physician review of the data (**PHYS**).

C.10.161 *WAV Category Result (OBX) Segment*—Contains the digital waveform data for the first sample at each time point, separated by repeat delimiters (~). Further result segments of various categories occur here, containing waveform data and analysis results for other samples at this recording site and data for other recording sites.

C.10.162 *Null Category Result (OBX) Segments*—Each of the result segments with no information category code contains one value to be reported to the ordering physician. The values include, for each of the five muscles examined, the insertional activity, fibrillation potentials, fasciculation potentials, and motor unit potentials activation, amplitude, duration, complexity (number of phases/turns), variability, and recruitment. In this example, coded entry (CE) values are given (that is, these quantities are graded on a relative or absolute scale using the **AS4** relative grading system or the grading system for abundance); alternatively, actual quantitative (NM) results could have been transmitted if desired.

C.10.163 *GDT Category Result (OBX) Segment*—Contains the EMG descriptive report.

C.10.164 *MDT Category Result (OBX) Segment*—Contains the EMG interpretation.

C.10.165 *DEV Category Result (OBX) Segment*—Identifies the device used for the study as a text description only.

C.10.166 *SER Category Result (OBX) Segment*—Identifies the serial number of the device used for the study.

C.10.167 *ANT and IMP Category Result (OBX) Segments*—Contain the three descriptive diagnostic impressions for the study (*mildly increased abundance insertional activity, very rare fibrillation potentials, mildly increased amplitude mildly increased complexity motor unit potentials*) using **AS4** diagnostic codes (**AS4&EMGD**), and a localization (muscles innervated by the *Right distal forearm/leg portion median nerve*) using SNOMED topographic location codes (**SNM+&TOPO**). Another IMP category result segment contains a clinical diagnosis (*carpal tunnel syndrome*) using ICD-9-CM codes (**I9C**). These IMP category result segments also contain the status flag **A**, abnormal.

C.10.168 *Patient ID (P) Segment*—Contains a sequence number (3), requestor- and producer-assigned patient ID numbers (both 4321098 with mod 10 check digit 8), subject name, birth date (January 23, 1960), sex (**F**), race (**W**), address, daytime and nighttime telephone numbers, primary physician ID number and name, height (142 cm), weight (55 kg), handedness (right), status (**OP** = outpatient), location or registration (Neuro), marital status (**M**), and registration date (March 23, 1990).

C.10.169 *Order (OBR) Segment*—Contains a sequence number (1), requestor-assigned accession number (5683^Neuro, indicating the 5683rd order generated by the neurologic clinic computer system), producer-assigned accession number (1235^EEG, indicating the 1235th order processed by the EEG laboratory computer system), test/observation ID (95930 = visual evoked potential), date and time requested (March 23, 1990 at 13:25:46), date and time study began (March 24, 1990 at 09:35:32), date and time study ended (March 24, 1990 at 09:38:58), action code (**N** = new order), clinical information, ordering physician's ID, name, and telephone number, date and time results of study reported (March 24, 1990 at 10:12:03), producer section (**EN** = electroneurophysiology), order status (**F** = final results), principal physician interpreting study, assisting interpreter or resident, technician performing study, and report transcriptionist. The physicians' names are preceded by a provider ID number, separated from the name by a component delimiter (^). The technician and transcriptionist names and the clinical information are also preceded by a component delimiter in order to allow a similar alphanumeric code to be given before the component delimiter if desired.

C.10.170 *DST Category Result (OBX) Segment*— Contains two distance measurements, the inion to nasion distance (36 cm) and the left-to-right preauricular point distance (36.5 cm).

C.10.171 *MTG Category Result (OBX) Segment*— Defines montage number 1, montage name *Std VEP montage*, containing four data channels.

C.10.172 *ELC Category Result (OBX) Segment*— Defines actual electrodes 1 to 4. The electrode location (origin of coordinate system), **T-Y0100** (center of head), and the electrode attributes (disks with collodion, tin, 0.4 cm) are specified only for electrode number 1, but apply to all electrodes. An electrode number, name, and theta and phi angular coordinates are given for each actual electrode.

C.10.173 *CHN Category Result (OBX) Segment*— Defines the four data channels by number and first and second electrode inputs. The channel sensitivity (0.05 μV), minimum and maximum values (-2048 to 2047), and filter settings (analog, passes 1 to 100 Hz with 6-dB/octave rolloff) are specified only for channel 1, but apply to all channels. The default sensitivity correction factor (1.0), channel baseline value (0), and time skew (0) are assumed for all channels. No sampling frequencies are specified.

C.10.174 *MED Category Result (OBX) Segment*— Indicates that the medication diazepam 5 mg PO was administered prior to the start of the study; only a text description (with no alphanumeric code) is given.

C.10.175 *TIM Category Result (OBX) Segment*— Defines the start of the first data epoch at a time 710.5 ms past 9:35:32 on March 24, 1990, as well as specifying the sampling interval (0.0005 s), the epoch length (0.250 s), the transmitted data format (**DNC**), the time from stimulus to start of epoch (0), the averaging method (**ALL** epochs), the number of epochs averaged (100), and the number of epochs rejected due to artifact (0). The test/ observation ID in field 4 of this and subsequent result segments is 95930.01110001 rather than 95930.0, to indicate that this portion of the study uses full field checkerboard pattern reversal stimuli to left eye and is the first trial for these stimulation conditions.

C.10.176 *ANA Category Result (OBX) Segment*— Contains the annotation *left eye, std check size*, which was generated by a technician review of the data (**TECH**).

C.10.177 *STM Category Result (OBX) Segment*— Defines the beginning of stimulation and the stimulus parameters for the visual evoked potential: pattern reversal (**PRV**), left eye (**T-XX000-LFT**), full-cycle reversal rate 1.05 Hz, duration of one pattern state 0.47619 s, intensity 170 cd/m^2, white light, contrast ratio 0.33, checkerboard pattern, check size 0.5° (30 min), size of visual field 15°.

C.10.178 *WAV Category Result (OBX) Segment*— Contains the averaged digital waveform data for the four channels at each time point in the 250-ms epoch (total 500 points).

C.10.179 *ANA Category Result (OBX) Segment*— Indicates a technician (**TECH**) marked N75 peak in channels 2 and 4 at peak latencies (**PKLA**) 84 and 82 ms, respectively, after the start of the epoch which began at 09:35:32 plus 710.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the N75 peaks in each channel are included. The analysis algorithm and type code and the units and names associated with the two parameters are specified only for channel 2, but apply to channel 4 as well.

C.10.180 *ANA Category Result (OBX) Segment*— Indicates a technician (**TECH**) marked P100 peak in channels 2 and 4 at peak latency (**PKLA**) 108 ms after the start of the epoch which began at 09:35:32 plus 710.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the P100 peaks in each channel are included.

C.10.181 *ANA Category Result (OBX) Segment*— Indicates a technician (**TECH**) marked N145 peak in channels 2 and 4 at peak latency (**PKLA**) 137 ms after the start of the epoch which began at 09:35:32 plus 710.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the N145 peaks in each channel are included.

C.10.182 *TIM Category Result (OBX) Segment*— Defines the start of the second data epoch at a time 125.0 ms past 9:36:24 on March 24, 1990, as well as specifying the sampling interval (0.0005 s), the epoch length (0.250 s), the transmitted data format (**DNC**), the time from stimulus to start of epoch (0), the averaging method (**ALL** epochs), the number of epochs averaged (100), and the number of epochs rejected due to artifact (1). The test/ observation ID in field 4 of this and subsequent result segments is 95930.01120001, to indicate that this portion of the study uses full field checkerboard pattern reversal stimuli to right eye and is the first trial for these stimulation conditions.

C.10.183 *ANA Category Result (OBX) Segment*— Contains the annotation *right eye, std check size*, which was generated by a technician review of the data (**TECH**).

C.10.184 *STM Category Result (OBX) Segment*— Defines the beginning of stimulation and the stimulus parameters for the visual evoked potential: pattern reversal (**PRV**), right eye (**T-XX000-RGT**), full-cycle reversal rate 1.05 Hz, duration of one pattern state 0.47619 s, intensity 170 cd/m^2, white light, contrast ratio 0.33, checkerboard pattern, check size 0.5° (30 min), size of visual field 15°.

C.10.185 *WAV Category Result (OBX) Segment*—Contains the averaged digital waveform data for the four channels at each time point in the 250-ms epoch (total 500 points).

C.10.186 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked N75 peak in channels 2 and 4 at peak latencies (**PKLA**) 77.5 and 76 ms, respectively, after the start of the epoch which began at 09:36:24 plus 125.0 ms on March 24, 1990. The amplitudes (**PKAM**) of the N75 peaks in each channel are included.

C.10.187 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked P100 peak in channels 2 and 4 at peak latencies (**PKLA**) 101 and 103 ms, respectively, after the start of the epoch which began at 09:36:24 plus 125.0 ms on March 24, 1990. The amplitudes (**PKAM**) of the P100 peaks in each channel are included.

C.10.188 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked N145 peak in channels 2 and 4 at peak latencies (**PKLA**) 126 and 131 ms, respectively, after the start of the epoch which began at 09:36:24 plus 125.0 ms on March 24, 1990. The amplitudes (**PKAM**) of the N145 peaks in each channel are included.

C.10.189 *TIM Category Result (OBX) Segment*—Defines the start of the third data epoch at a time 240.5 ms past 9:37:15 on March 24, 1990, as well as specifying the sampling interval (0.0005 s), the epoch length (0.250 s), the transmitted data format (**DNC**), the time from stimulus to start of epoch (0), the averaging method (**ALL** epochs), the number of epochs averaged (100), and the number of epochs rejected due to artifact (0). The test/observation ID in field 4 of this and subsequent result segments is 95930.01110002, to indicate that this portion of the study uses full field checkerboard pattern reversal stimuli to left eye and is the second trial for these stimulation conditions.

C.10.190 *ANA Category Result (OBX) Segment*—Contains the annotation *left eye, large check size*, which was generated by a technician review of the data (**TECH**).

C.10.191 *STM Category Result (OBX) Segment*—Defines the beginning of stimulation and the stimulus parameters for the visual evoked potential: pattern reversal (**PRV**), left eye (**T-XX000-LFT**), full-cycle reversal rate 1.05 Hz, duration of one pattern state 0.47619 s, intensity 170 cd/m^2, white light, contrast ratio 0.33, checkerboard pattern, check size 1.0° (60 min), size of visual field 15°.

C.10.192 *WAV Category Result (OBX) Segment*—Contains the averaged digital waveform data for the four channels at each time point in the 250-ms epoch (total 500 points).

C.10.193 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked N75 peak in channels 2 and 4 at peak latencies (**PKLA**) 82 and 80 ms, respectively, after the start of the epoch which began at 09:37:15 plus 240.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the N75 peaks in each channel are included.

C.10.194 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked P100 peak in channels 2 and 4 at peak latency (**PKLA**) 106 ms after the start of the epoch which began at 09:37:15 plus 240.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the P100 peaks in each channel are included.

C.10.195 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked N145 peak in channels 2 and 4 at peak latencies (**PKLA**) 134 and 135 ms, respectively, after the start of the epoch which began at 09:37:15 plus 240.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the N145 peaks in each channel are included.

C.10.196 *TIM Category Result (OBX) Segment*—Defines the start of the fourth data epoch at a time 580.5 ms past 9:38:02 on March 24, 1990, as well as specifying the sampling interval (0.0005 s), the epoch length (0.250 s), the transmitted data format (**DNC**), the time from stimulus to start of epoch (0), the averaging method (**ALL** epochs), the number of epochs averaged (100), and the number of epochs rejected due to artifact (1). The test/observation ID in field 4 of this and subsequent result segments is 95930.01120002, to indicate that this portion of the study uses full field checkerboard pattern reversal stimuli to right eye and is the second trial for these stimulation conditions.

C.10.197 *ANA Category Result (OBX) Segment*—Contains the annotation *right eye, large check size*, which was generated by a technician review of the data (**TECH**).

C.10.198 *STM Category Result (OBX) Segment*—Defines the beginning of stimulation and the stimulus parameters for the visual evoked potential: pattern reversal (**PRV**), right eye (**T-XX000-RGT**), full-cycle reversal rate 1.05 Hz, duration of one pattern state

0.47619 s, intensity 170 cd/m^2, white light, contrast ratio 0.33, checkerboard pattern, check size 1.0° (60 min), size of visual field 15°.

C.10.199 *WAV Category Result (OBX) Segment*—Contains the averaged digital waveform data for the four channels at each time point in the 250-ms epoch (total 500 points).

C.10.200 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked N75 peak in channels 2 and 4 at peak latencies (**PKLA**) 75 and 73.5 ms, respectively, after the start of the epoch which began at 09:38:02 plus 580.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the N75 peaks in each channel are included.

C.10.201 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked P100 peak in channels 2 and 4 at peak latencies (**PKLA**) 99 and 101 ms, respectively, after the start of the epoch which began at 09:38:02 plus 580.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the P100 peaks in each channel are included.

C.10.202 *ANA Category Result (OBX) Segment*—Indicates a technician (**TECH**) marked N145 peak in channels 2 and 4 at peak latencies (**PKLA**) 124 and 123 ms, respectively, after the start of the epoch which began at 09:38:02 plus 580.5 ms on March 24, 1990. The amplitudes (**PKAM**) of the N145 peaks in each channel are included.

C.10.203 *Null Category Result (OBX) Segments*—Each of the result segments with no information category code contains one numeric (NM) or coded entry (CE) value to be reported to the ordering physician. The stimulus rate, visual pattern element size, and visual field size for each eye stimulated and for each of the two trials (number one using a standard check size, and number two using a large check size) are reported. Also, the N75, P100, and N145 peak latencies and morphologies in channel 2 for each eye stimulated, and the absolute left-right P100 peak latency differences, are reported for each of the two trials. Morphologies are reported as coded entry (CE) values using the **AS4** coding system (**AS4&MRPH**). The normal ranges are also reported for numeric values, as well as a normalcy status flag (**N** = normal, **H** = high) and an indication that age and sex based controls were used in determining normal values for latencies.

C.10.204 *GDT Category Result (OBX) Segment*—Contains the VEP descriptive report.

C.10.205 *MDT Category Result (OBX) Segment*—Contains the VEP interpretation.

C.10.206 *DEV Category Result (OBX) Segment*—Identifies the device used for the recording as a text description only.

C.10.207 *SER Category Result (OBX) Segment*—Identifies the serial number of the device used for the recording.

C.10.208 *ANT and IMP Category Result (OBX) Segments*—Contain the diagnostic impression for the study and its localization (*Normal, Bilaterally*) using **AS4** diagnosis codes (**AS4&VEPD**) and **AS4** localization (distribution) codes (**AS4&DIST**), respectively.

C.10.209 *Message Trailer (L) Segment (Sequence Number 1)*—Marks the end of the transmission, and specifies the number of patient segments (3) and the total number of lines (819723) in the message and a batch number (19264) which here is the same as the message control ID in the message header segment.

```
H|^~\&|19264|34X96ABE59YW|NEULAB (Sunnyville Neurophysiology Lab)|<CR>
A|102 W Main Street^Mail Stop 29B^Sunnyville^IN^66666|ORU^R01|(555)444-3333|<CR>
A||Neuro (Sunnyville Neurologic Clinic)|Example|P|E.3|19900324101215<CR>
P|1|4567890&1&M10|4567890&1&M10|3-777-222|Doe^John^Q^Jr^Mr|Deere|19300202|<CR>
A|M|W|511 Third Avenue^Apt 2^Hometown^IN^66667||445-1111Cday~445-2222Cevening<CR>
A||32975^Smith&John&P&III&Dr&MD^UPIN|||160^cm|60^kg|401.9^Hypertension^I9C|<CR>
A|Propranolol~diazepam|Last meal 12 hrs ago||Right|19900214|IP|Psych||C|<CR>
A|M|BP|English|PSY|19900214<CR>
OBR|1|5678^Neuro|1234^EEG|95816^EEG recording||19900323095216|<CR>
A|19900324081216|19900324085142|||N|^dementia|^60 year old male with 3 month hx <CR>
A|of myoclonus, cognitive decline, and memory loss|||32975^Smith&John&P&III&<CR>
A|Dr&MD|<CR>
A|444-3555|||||19900324101017|214.50|EN|F|||||WHLC||97235^Berger&Hans&&&Dr|<CR>
A|27593^Jones&Mary&S&&Dr&MD|^Sullivan&Joyce&D&&Ms|^Quincy&Susan&R&&Ms<CR>
OBX|1|CM|95816&DST^EEG recording|1|T-10147&<CR>
A|external occipital protuberance (inion)^T-12171&frontonasal suture (nasion)^<CR>
A|36.5~<CR>
A|T-Y0171-LFT&left preauricular area^T-Y0171-RGT&right preauricular area^37<CR>
OBX|2|CM|95816&MTG|1|1&LR-21.1 (A1/2)^21<CR>
OBX|3|CM|95816&ELC|1|1&Fp1^T-Y0100&head^DP&Au&0.6^90&TH^108&PH~<CR>
A|2&Fp2^^^90&TH^72&PH~3&F3^^^64&TH^129.1&PH~4&F4^^^64&TH^<CR>
```

FIG. C-1 Example Message for Neurophysiological Data

```
A|50.9&PH~5&C3^^^45&TH^180&PH~6&C4^^^45&TH^0&PH~7&P3^^^64&TH^<CR>
A|230.9&PH~8&P4^^^64&TH^309.1&PH~9&O1^^^90&TH^252&PH~10&O2^^^<CR>
A|90&TH^288&PH~11&F7^^^90&TH^144&PH~12&F8^^^90&TH^36&PH~<CR>
A|13&T3^^^90&TH^180&PH~14&T4^^^90&TH^0&PH~15&T5^^^90&TH^216&PH~<CR>
A|16&T6^^^90&TH^324&PH~17&Fpz^^^90&TH^90&PH~18&Fz^^^45&TH^<CR>
A|90&PH~19&Cz^^^0&TH^0&PH~20&Pz^^^45&TH^270&PH~21&Oz^^^90&TH^<CR>
A|270&PH~22&A1^^^120&TH^180&PH~23&A2^^^120&TH^0&PH~24&Av^^DERIV^<CR>
A|0.5&A1^0.5&A2<CR>
OBX|4|CM|95816&CHN|1|1^CAL^0.5&uv^^^-2048&2047^BP&ANA&1&6&70&6~<CR>
A|2^CAL~3^CAL~4^CAL~5^CAL~6^CAL~7^CAL~8^CAL~9^CAL~10^CAL~<CR>
A|11^CAL~12^CAL~13^CAL~14^CAL~15^CAL~16^CAL~17^CAL~18^CAL~<CR>
A|19^CAL~20^CAL~21^CAL<CR>
OBX|5|CM|95816.9100&TIM^EEG recording, during square wave calibration|1|<CR>
A|19900324081216.130^0.005^^DNC<CR>
OBX|6|CM|95816.9100&STM|1|BEGIN^CAL^^0.5^1^50.0^uv<CR>
OBX|7|RP|95816.9100&WAV|1|:P4567890.dat:0:8400^^application&int16<CR>
OBX|8|CM|95816.9100&ANA|1|1&CAL&ON^51.6&PKAM&uv^0&BASE^<CR>
A|1.12&LLF&hz~2^50.75^0^0.92~3^49.15^0^1.03~4^50.25^0^0.94~<CR>
A|5^48.2^1^1.10~6^49.65^0^1.04~7^49.45^0^0.96~8^50.65^0^<CR>
A|0.99~9^55.3^0^1.06~10^49.6^2^1.00~11^49.35^0^0.97~12^<CR>
A|50.1^0^1.01~13^53.8^-1^1.12~14^55.6^0^0.91~15^49.4^0^<CR>
A|0.89~16^54.35^0^1.08~17^49.6^0^1.03~18^56.75^0^0.94~19^<CR>
A|49.4^0^1.01~20^55.15^0^1.08~21^49.9^0^0.96<CR>
OBX|9|RP|95816.9100&WAV|2|::8400:8400^^application&int16<CR>
OBX|10|CM|95816.9100&ANA|2|1&CAL&OFF^51.6&PKAM&uv^0&BASE^<CR>
A|1.12&LLF&hz~2^50.75^0^0.92~3^49.15^0^1.03~4^50.25^0^0.94~<CR>
A|5^48.2^1^1.10~6^49.65^0^1.04~7^49.45^0^0.96~8^50.65^0^<CR>
A|0.99~9^55.3^0^1.06~10^49.6^2^1.00~11^49.35^0^0.97~12^<CR>
A|50.1^0^1.01~13^53.8^-1^1.12~14^55.6^0^0.91~15^49.4^0^<CR>
A|0.89~16^54.35^0^1.08~17^49.6^0^1.03~18^56.75^0^0.94~19^<CR>
A|49.4^0^1.01~20^55.15^0^1.08~21^49.9^0^0.96<CR>
⋮
OBX|17|CM|95816.9100&STM|2|END^CAL^^0.5^1^50.0^uv<CR>
OBX|18|CM|95816&CHN^EEG recording|2|1^Fp1&O2^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&70&6~2^Fp1&O2^^1.015&0~3^Fp1&O2^^0.983&0~4^Fp1&O2^^<CR>
A|1.005&0~5^Fp1&O2^^0.964&1~6^Fp1&O2^^0.993&0~7^Fp1&O2^^<CR>
A|0.989&0~8^Fp1&O2^^1.013&0~9^Fp1&O2^^1.106&0~10^Fp1&O2^^<CR>
A|0.992&2~11^Fp1&O2^^0.987&0~12^Fp1&O2^^1.002&0~13^Fp1&O2^^<CR>
A|1.076&-1~14^Fp1&O2^^1.112&0~15^Fp1&O2^^0.988&0~16^Fp1&O2^^<CR>
A|1.087&0~17^Fp1&O2^^0.992&0~18^Fp1&O2^^1.135&0~19^Fp1&O2^^<CR>
A|0.988&0~20^Fp1&O2^^1.103&0~21^Fp1&O2^^0.998&0<CR>
OBX|19|CM|95816.9301&TIM^EEG recording, during biocalibration while awake with <CR>
A|eyes closed|2|19900324081226.815^0.005^^DNC<CR>
OBX|20|CM|95816.9301&ANA|3|&MACH&BBIO&&&Begin biocal<CR>
OBX|21|CM|95816.9301&ANA|4|&MAN&AWAK&&&Awake<CR>
OBX|22|CM|95816.9301&ANA|5|&MAN&ECLO&&&Eyes closed<CR>
OBX|23|RP|95816.9301&WAV|6|::42000:67200^^application&int16
OBX|24|CM|95816&CHN^EEG recording|3|1^Fp1&Av^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&70&6~2^Fp2&Av^^1.015&0~3^F3&Av^^0.983&0~4^F4&Av^^<CR>
A|1.005&0~5^C3&Av^^0.964&1~6^C4&Av^^0.993&0~7^P3&Av^^0.989&0~8^P4&Av^^<CR>
A|1.013&0~9^O1&Av^^1.106&0~10^O2&Av^^0.992&2~11^F7&Av^^<CR>
A|0.987&0~12^F8&Av^^1.002&0~13^T3&Av^^1.076&-1~14^T4&Av^^<CR>
A|1.112&0~15^T5&Av^^0.988&0~16^T6&Av^^1.087&0~17^Fpz&Av^^<CR>
A|0.992&0~18^Fz&Av^^1.135&0~19^Cz&Av^^0.988&0~20^Pz&Av^^<CR>
A|1.103&0~21^Oz&Av^^0.998&0<CR>
OBX|25|CM|95816.0101&TIM^EEG recording, with standard conditions while awake <CR>
A|with eyes closed|3|19900324081237.525^0.005^^DNC<CR>
OBX|26|CM|95816.0101&ANA|6|&MAN&AWAK&&&Awake<CR>
OBX|27|CM|95816.0101&ANA|7|&MAN&ECLO&&&Eyes closed<CR>
OBX|28|RP|95816.0101&WAV|7|::109200:84000^^application&int16
⋮
OBX|35|CM|95816&CHN^EEG recording|4|1^Fp1&Av^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&15&6~2^Fp2&Av^^1.015&0~3^F3&Av^^0.983&0~4^F4&Av^^<CR>
A|1.005&0~5^C3&Av^^0.964&1~6^C4&Av^^0.993&0~7^P3&Av^^0.989&0~8^P4&Av^^<CR>
A|1.013&0~9^O1&Av^^1.106&0~10^O2&Av^^0.992&2~11^F7&Av^^<CR>
A|0.987&0~12^F8&Av^^1.002&0~13^T3&Av^^1.076&-1~14^T4&Av^^<CR>
A|1.112&0~15^T5&Av^^0.988&0~16^T6&Av^^1.087&0~17^Fpz&Av^^<CR>
A|0.992&0~18^Fz&Av^^1.135&0~19^Cz&Av^^0.988&0~20^Pz&Av^^<CR>
A|1.103&0~21^Oz&Av^^0.998&0<CR>
OBX|36|RP|95816.0101&WAV^EEG recording, with standard conditions while awake <CR>
```

FIG. C-1 *(continued)*

```
A|with eyes closed|14|::697200:84000^^application&int16
⋮
OBX|56|CM|95816.0101&ANA|8|1&AUTO&SHW&&&&19900324081237.525^<CR>
A|142.355&PKLA&s^32&TODR^13&PKDR^62&PKAM~2^142.355^34^14^59~3^142.355^<CR>
A|33^12^55~5^142.355^31^14^50~7^142.355^33^12^39~11^142.355^33^<CR>
A|13^57~17^142.355^33^14^60~18^142.355^32^13^53~19^142.355^<CR>
A|34^14^47<CR>
OBX|57|RP|95816.0101&WAV|34|::2377200:42^^application&int16
OBX|58|CM|95816.0101&ANA|9|4&AUTO&SHW&&&&19900324081237.525^<CR>
A|142.360&PKLA&s^31&TODR^14&PKDR^52&PKAM~6^142.360^30^12^44~8^142.360^<CR>
A|32^11^35~9^142.360^33^13^24~10^142.360^34^14^16~12^142.360^<CR>
A|31^12^48~13^142.360^33^13^53~14^142.360^32^13^39~15^<CR>
A|142.360^33^14^42~16^142.360^31^12^30~20^142.360^34^15^37~<CR>
A|21^142.360^32^12^21<CR>
OBX|59|RP|95816.0101&WAV|35|::2377242:42^^application&int16
OBX|60|CM|95816.0101&ANA|10|&MAN&&&&Jerk<CR>
OBX|61|RP|95816.0101&WAV|36|::2377284:84000^^application&int16
⋮
OBX|261|CM|95816.2101&TIM^EEG recording, during hyperventilation while awake with <CR>
A|eyes closed|4|19900324082538.315^0.005^^DNC<CR>
OBX|262|CM|95816.2101&ANA|40|&MAN&BGHV&&&Begin HV<CR>
OBX|263|CM|95816.2101&ANA|41|&MAN&AWAK&&&Awake<CR>
OBX|264|CM|95816.2101&ANA|42|&MAN&ECLO&&&Eyes closed<CR>
OBX|265|RP|95816.2101&WAV|137|::10861284:84000^^application&int16
⋮
OBX|309|CM|95816&ELC^EEG recording|2|25&Strobe^^FLS<CR>
OBX|310|CM|95816&CHN|5|1^Strobe^0.5&uv^1.032&0^^-2048&2047^<CR>
A|BP&ANA&1&6&15&6~2^Fp2&Av^^1.015&0~3^F3&Av^^0.983&0~4^F4&Av^^<CR>
A|1.005&0~5^C3&Av^^0.964&1~6^C4&Av^^0.993&0~7^P3&Av^^0.989&0~8^P4&Av^^<CR>
A|1.013&0~9^O1&Av^^1.106&0~10^O2&Av^^0.992&2~11^F7&Av^^<CR>
A|0.987&0~12^F8&Av^^1.002&0~13^T3&Av^^1.076&-1~14^T4&Av^^<CR>
A|1.112&0~15^T5&Av^^0.988&0~16^T6&Av^^1.087&0~17^Fpz&Av^^<CR>
A|0.992&0~18^Fz&Av^^1.135&0~19^Cz&Av^^0.988&0~20^Pz&Av^^<CR>
A|1.103&0~21^Oz&Av^^0.998&0<CR>
OBX|311|CM|95816.3101&TIM^EEG recording, during photic stimulation while awake <CR>
A|with eyes closed|5|19900324084048.620^0.005^^DNC<CR>
OBX|312|CM|95816.3101&ANA|49|&MACH&BPHO&&&Begin photic<CR>
OBX|313|CM|95816.3101&ANA|50|&MAN&AWAK&&&Awake<CR>
OBX|314|CM|95816.3101&ANA|51|&MAN&ECLO&&&Eyes closed<CR>
OBX|315|CM|95816.3101&STM|3|BEGIN^FLS^T-XX000-BIL&bilateral eye^1^0.00001^<CR>
A|22^cd.s/m2^WHT<CR>
OBX|316|RP|95816.3101&WAV|160|::12793284:420^^application&int16
OBX|317|CM|95816.3101&ANA|98|1&AUTO&FLS&&&&19900324084048.620^<CR>
A|1.215&ONLA&s<CR>
OBX|318|RP|95816.3101&WAV|161|::10861704:8400^^application&int16
⋮
OBX|2934|CM|95816&CHN^EEG recording|6|1^CAL^0.5&uv^^^-2048&2047^<CR>
A|BP&ANA&1&6&70&6~2^CAL~3^CAL~4^CAL~5^CAL~6^CAL~7^CAL~8^CAL~<CR>
A|9^CAL~10^CAL~11^CAL~12^CAL~13^CAL~14^CAL~15^CAL~16^CAL~<CR>
A|17^CAL~18^CAL~19^CAL~20^CAL~21^CAL<CR>
OBX|2935|CM|95816.9100&TIM^EEG recording, during square wave calibration|6|<CR>
A|19900324085120.670^0.005^^DNC<CR>
OBX|2936|CM|95816.9100&STM|40|BEGIN^CAL^^0.5^1^50.0^uv<CR>
OBX|2937|RP|95816.9100&WAV|1629|::134098104:8400^^application&int16
OBX|2938|CM|95816.9100&ANA|1527|1&CAL&ON^51.6&PKAM&uv^0&BASE^<CR>
A|1.12&LLF&hz~2^50.75^0^0.92~3^49.15^0^1.03~4^50.25^0^0.94~<CR>
A|5^48.2^1^1.10~6^49.65^0^1.04~7^49.45^0^0.96~8^50.65^0^<CR>
A|0.99~9^55.3^0^1.06~10^49.6^2^1.00~11^49.35^0^0.97~12^<CR>
A|50.1^0^1.01~13^53.8^-1^1.12~14^55.6^0^0.91~15^49.4^0^<CR>
A|0.89~16^54.35^0^1.08~17^49.6^0^1.03~18^56.75^0^0.94~19^<CR>
A|49.4^0^1.01~20^55.15^0^1.08~21^49.9^0^0.96<CR>
OBX|2939|RP|95816.9100&WAV|1630|::134106504:8400^^application&int16
OBX|2940|CM|95816.9100&ANA|1528|1&CAL&OFF^51.6&PKAM&uv^0&BASE^<CR>
A|1.12&LLF&hz~2^50.75^0^0.92~3^49.15^0^1.03~4^50.25^0^0.94~<CR>
A|5^48.2^1^1.10~6^49.65^0^1.04~7^49.45^0^0.96~8^50.65^0^<CR>
A|0.99~9^55.3^0^1.06~10^49.6^2^1.00~11^49.35^0^0.97~12^<CR>
A|50.1^0^1.01~13^53.8^-1^1.12~14^55.6^0^0.91~15^49.4^0^<CR>
A|0.89~16^54.35^0^1.08~17^49.6^0^1.03~18^56.75^0^0.94~19^<CR>
A|49.4^0^1.01~20^55.15^0^1.08~21^49.9^0^0.96<CR>
⋮
```

FIG. C-1 *(continued)*

```
OBX|2947|CM|95816.9100&STM|41|END^CAL^^0.5^1^50.0^uv<CR>
OBX|2948|CM|95816&CHN^EEG recording|7|1^CAL^0.5&uv^^^-2048&2047^<CR>
A|BP&ANA&1&6&15&6~2^CAL~3^CAL~4^CAL~5^CAL~6^CAL~7^CAL~8^CAL~<CR>
A|9^CAL~10^CAL~11^CAL~12^CAL~13^CAL~14^CAL~15^CAL~16^CAL~<CR>
A|17^CAL~18^CAL~19^CAL~20^CAL~21^CAL<CR>
OBX|2949|CM|95816.9100&TIM^EEG recording, during square wave calibration|7|<CR>
A|19900324085130.925^0.005^^DNC<CR>
OBX|2950|CM|95816.9100&STM|42|BEGIN^CAL^^0.5^1^50.0^uv<CR>
OBX|2951|RP|95816.9100&WAV|1634|::134140104:8400^^application&int16
OBX|2952|CM|95816.9100&ANA|1532|1&CAL&ON^51.6&PKAM&uv^0&BASE^<CR>
A|1.12&LLF&hz~2^50.75^0^0.92~3^49.15^0^1.03~4^50.25^0^0.94~<CR>
A|5^48.2^1^1.10~6^49.65^0^1.04~7^49.45^0^0.96~8^50.65^0^<CR>
A|0.99~9^55.3^0^1.06~10^49.6^2^1.00~11^49.35^0^0.97~12^<CR>
A|50.1^0^1.01~13^53.8^-1^1.12~14^55.6^0^0.91~15^49.4^0^<CR>
A|0.89~16^54.35^0^1.08~17^49.6^0^1.03~18^56.75^0^0.94~19^<CR>
A|49.4^0^1.01~20^55.15^0^1.08~21^49.9^0^0.96<CR>
OBX|2953|RP|95816.9100&WAV|1635|::134148504:8400^^application&int16
OBX|2954|CM|95816.9100&ANA|1533|1&CAL&OFF^51.6&PKAM&uv^0&BASE^<CR>
A|1.12&LLF&hz~2^50.75^0^0.92~3^49.15^0^1.03~4^50.25^0^0.94~<CR>
A|5^48.2^1^1.10~6^49.65^0^1.04~7^49.45^0^0.96~8^50.65^0^<CR>
A|0.99~9^55.3^0^1.06~10^49.6^2^1.00~11^49.35^0^0.97~12^<CR>
A|50.1^0^1.01~13^53.8^-1^1.12~14^55.6^0^0.91~15^49.4^0^<CR>
A|0.89~16^54.35^0^1.08~17^49.6^0^1.03~18^56.75^0^0.94~19^<CR>
A|49.4^0^1.01~20^55.15^0^1.08~21^49.9^0^0.96<CR>
⋮
OBX|2961|CM|95816.9100&STM|43|END^CAL^^0.5^1^50.0^uv<CR>
OBX|2962|NM|95816.01010000141^EEG recording, with standard conditions while awake <CR>
A|with eyes closed: theta activity abundance||100|%<CR>
OBX|2963|NM|95816.01010000142^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: theta activity amplitude||15|uv<CR>
OBX|2964|NM|95816.01010000143^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: theta activity frequency||5|hz<CR>
OBX|2965|CE|95816.01010000145^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: theta activity asymmetry||4^symmetric^AS4&ASYM<CR>
OBX|2966|CE|95816.01010000146^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: theta activity reactivity||2^slightly reactive^<CR>
A|AS4&REAC<CR>
OBX|2967|CE|95816.01010000149^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: theta activity distribution||0010^generalized^AS4&<CR>
A|DIST<CR>
OBX|2968|NM|95816.01010000561^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: periodic sharp waves abundance||70|%<CR>
OBX|2969|NM|95816.01010000562^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: periodic sharp waves amplitude||100|uv<CR>
OBX|2970|NM|95816.01010000563^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: periodic sharp waves frequency||1.5|hz<CR>
OBX|2971|NM|95816.01010000564^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: periodic sharp waves duration||0.2|s<CR>
OBX|2972|CE|95816.01010000565^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: periodic sharp waves asymmetry||4^symmetric^AS4&<CR>
A|ASYM<CR>
OBX|2973|CE|95816.01010000569^EEG recording, with standard conditions while <CR>
A|awake with eyes closed: periodic sharp waves distribution||0017^<CR>
A|generalized, maximal anterior head region^AS4&DIST<CR>
OBX|2974|TX|95816&GDT^EEG recording|1|   The background during wakefulness <CR>
A|contained poorly formed, symmetric theta activity of average amplitude 15 <CR>
A|uv and average frequency 5 Hz in a generalized distribution, which <CR>
A|showed little reactivity to eye opening or alerting procedures.  The major <CR>
A|feature of the recording was the presence of intermittent, symmetric <CR>
A|periodic sharp waves in a generalized distribution, maximal anteriorly, <CR>
A|with a duration of about 0.2 sec and an amplitude of about 100 microvolts, <CR>
A|repeating at a frequency of about 1.5 per second.  These were present <CR>
A|during about 70% of the recording.  They were often accompanied by visible <CR>
A|myoclonic jerks.  Sometimes, jerks could be elicited by loud sounds or by <CR>
A|touching the subject.~~   Hyperventilation was performed with poor effort, <CR>
A|and produced no change in the background.  Photic stimulation elicited <CR>
A|little evidence of a driving response.<CR>
OBX|2975|TX|95816&MDT|1|   The present recording shows nonspecific <CR>
A|generalized irregularities of cerebral function consisting of slowing of <CR>
A|the background, as seen on the previous EEG performed 2/15/90.  In <CR>
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FIG. C-1 *(continued)*

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A|addition, there are now periodic generalized sharp waves of the type seen <CR>
A|in Creutzfeldt-Jakob disease, or in certain types of metabolic disorders <CR>
A|such as post-anoxic encephalopathy, hypothyroidism, or baclofen or lithium <CR>
A|intoxication.  These were correlated with the subject's myoclonic jerks at <CR>
A|times.~~   If clinically indicated, a follow-up examination in 1 month <CR>
A|could be used for further evaluation.<CR>
OBX|2976|CE|95816&DEV|1|^Grass model 8 (21 channels) with PC-based computer<CR>
OBX|2977|ST|95816&SER|1|024567<CR>
OBX|2978|CE|95816&CNP|1|95816.2100^EEG recording, during hyperventilation^<CR>
A|AS4&TEST<CR>
OBX|2979|CE|95816&CNP|2|95816.3100^EEG recording, during photic stimulation^<CR>
A|AS4&TEST<CR>
OBX|2980|CE|95816&ANT|1|0017^Generalized, maximal anterior head region^<CR>
A|AS4&DIST<CR>
OBX|2981|CE|95816&IMP|1|7156^Very frequent periodic sharp waves^<CR>
A|AS4&EEGD|||A~W<CR>
OBX|2982|CE|95816&ANT|2|0010^Generalized^AS4&DIST<CR>
OBX|2983|CE|95816&IMP|2|910214^Continuous low-amplitude theta activity^<CR>
A|AS4&EEGD|||A~W<CR>
OBX|2984|CE|95816.2100&IMP^EEG recording, during hyperventilation|3|<CR>
A|8^No activation^AS4&EEGD<CR>
OBX|2985|CE|95816.3100&IMP^EEG recording, during photic stimulation|4|<CR>
A|8^No activation^AS4&EEGD<CR>
OBX|2986|CE|95816&REC^EEG recording|1|95816^EEG recording: 30 days^AS4&TEST<CR>
P|2|3321123&6&M10|3321123&6&M10||Newton^Isaac^M^^Mr||19530810|M|W|<CR>
A|567 Center Street^^Pleasantville^IN^66661||441-6666Cday~441-7777Cevening|<CR>
A|42678^Welby&Marcus&L&&Dr&MD^UPIN|||153^cm|74^kg|||||Right~Right||<CR>
A|OP|Neuro|||M||||19900320<CR>
OBR|1|5692^Neuro|2314^EMG|95900^Motor nerve conduction study||<CR>
A|19900323151649|19900324083012|19900324084128|||N||^36 year old male with 6 <CR>
A|month hx of tingling and pain in thumb, index, and middle finger of right <CR>
A|hand.  Rule out carpal tunnel syndrome.|||42678^Welby&Marcus&L&&Dr&MD|<CR>
A|444-2323|||||19900324101118||EN|F|||||||27384^Samson&George&T&&Dr&MD|56372^<CR>
A|Smith&Benjamin&S&&Dr&MD|^Kirk&Bonnie&P&&Ms|^Quincy&Susan&R&&Ms<CR>
OBX|1|CM|95900&MTG^Motor nerve conduction study|1|1^1<CR>
OBX|2|CM|95900&ELC|1|1&G1^T-13882-RGT-BEL&right belly abductor pollicis <CR>
A|brevis muscle^DT&Sn&0.4~2&G2^T-13882-RGT-INS&right insertion abductor <CR>
A|pollicis brevis muscle<CR>
OBX|3|CM|95900&CHN|1|1^G1&G2^5.0&uv^^^-2048&2047^BP&ANA&1&6&7000&6<CR>
OBX|4|CM|95900.288290001&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal forearm or leg site: sample number 1|1|19900324083022.7105^0.0001^<CR>
A|0.040^DNC<CR>
OBX|5|CM|95900.288290001&STM|1|^ECD^T-X9180-RGT-LC9&right distal <CR>
A|forearm/leg portion median nerve^^0.0001^10^ma<CR>
OBX|6|CM|95900.288290001&WAV|1|1~6~21~36~65~81~61~50~42~<CR>
A|31~10~1~-11~-46~-18~1~0~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~4~15~24~35~45~53~~52~~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|7|CM|95900.288290002&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal forearm or leg site: sample number 2|2|19900324083025.1230^0.0001^<CR>
A|0.040^DNC<CR>
OBX|8|CM|95900.288290002&STM|2|^ECD^T-X9180-RGT-LC9&right distal <CR>
A|forearm/leg portion median nerve^^0.0001^20^ma<CR>
OBX|9|CM|95900.288290002&WAV|2|1~11~42~72~134~163~123~103~84~<CR>
A|62~21~2~-21~-93~-37~1~0~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~44~152~247~353~459~533~532~~533~~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|10|CM|95900.288290003&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal forearm or leg site: sample number 3|3|19900324083027.6625^0.0001^<CR>
A|0.040^DNC<CR>
OBX|11|CM|95900.288290003&STM|3|^ECD^T-X9180-RGT-LC9&right distal <CR>
A|forearm/leg portion median nerve^^0.0001^30^ma<CR>
OBX|12|CM|95900.288290003&WAV|3|3~18~63~108~195~243~183~150~126~<CR>
A|93~30~3~-33~-138~-54~3~0~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~86~274~486~739~951~1062~1064~1065~1067~1066~<CR>
```

FIG. C-1 *(continued)*

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⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|13|CM|95900.288290004&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal forearm or leg site: sample number 4|4|19900324083030.0372^0.0001^<CR>
A|0.040^DNC<CR>
OBX|14|CM|95900.288290004&STM|4|^ECD^T-X9180-RGT-LC9&right distal <CR>
A|forearm/leg portion median nerve^^0.0001^40^ma<CR>
OBX|15|CM|95900.288290004&WAV|4|4~24~84~144~260~324~244~200~168~<CR>
A|124~40~4~-44~-184~-72~4~0~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~86~274~486~739~951~1062~1064~1065~1067~1066~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|16|CM|95900.288290004&ANA|1|1&TECH&CMAP&&&&19900324083030.0372^<CR>
A|4.07&ONLA&ms^5.33&PKAM&mv<CR>
OBX|17|CM|95900.288260001&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal arm or thigh site: sample number 1|5|19900324083122.7105^0.0001^<CR>
A|0.040^DNC<CR>
OBX|18|CM|95900.288260001&STM|5|^ECD^T-X9180-RGT-LC6&right distal <CR>
A|arm/thigh portion median nerve^^0.0001^10^ma<CR>
OBX|19|CM|95900.288260001&WAV|5|1~5~3~2~1~0~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~4~15~24~35~45~53~~52~~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|20|CM|95900.288260002&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal arm or thigh site: sample number 2|6|19900324083125.2158^0.0001^<CR>
A|0.040^DNC<CR>
OBX|21|CM|95900.288260002&STM|6|^ECD^T-X9180-RGT-LC6&right distal <CR>
A|arm/thigh portion median nerve^^0.0001^20^ma<CR>
OBX|22|CM|95900.288260002&WAV|6|2~10~6~4~2~0~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~20~75~128~187~194~196~~195~~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|23|CM|95900.288260003&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal arm or thigh site: sample number 3|7|1990032408083127.8462^0.0001^<CR>
A|0.040^DNC<CR>
OBX|24|CM|95900.288260003&STM|7|^ECD^T-X9180-RGT-LC6&right distal <CR>
A|arm/thigh portion median nerve^^0.0001^30^ma<CR>
OBX|25|CM|95900.288260003&WAV|7|3~15~9~6~3~0~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~86~274~486~739~951~1062~1064~1065~1067~1066~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|26|CM|95900.288260004&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal arm or thigh site: sample number 4|8|19900324083130.1873^0.0001^<CR>
A|0.040^DNC<CR>
OBX|27|CM|95900.288260004&STM|8|^ECD^T-X9180-RGT-LC6&right distal <CR>
A|arm/thigh portion median nerve^^0.0001^40^ma<CR>
OBX|28|CM|95900.288260004&WAV|8|4~20~12~8~4~0~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~86~274~486~739~951~1062~1064~1065~1067~1066~<CR>
⋮
A|1~0~~~~~~~~~~~~~~~~~~~~~~~<CR>
OBX|29|CM|95900.288260004&ANA|2|1&TECH&CMAP&&&&19900324083130.1873^<CR>
A|9.92&ONLA&ms^5.21&PKAM&mv<CR>
OBX|30|CM|95900&DST^Motor nerve conduction study|1|T-X9180-RGT-LC6&right <CR>
A|distal arm/thigh portion median nerve^T-X9180-RGT-LC9&right distal forearm/<CR>
A|leg portion median nerve^30.4<CR>
OBX|31|CM|95900&ELC|2|1&G1^T-13940-RGT-BEL&right belly abductor digiti <CR>
A|minimi muscle of hand^DT&Sn&0.4~2&G2^T-13940-RGT-INS&right insertion <CR>
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FIG. C-1 *(continued)*

```
A|abductor digiti minimi muscle of hand<CR>
OBX|32|CM|95900.294090001&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal forearm or leg site: sample number 1|9|19900324083422.7105^<CR>
A|0.0001^0.040^DNC<CR>
OBX|33|CM|95900.294090001&STM|9|^ECD^T-X9170-RGT-LC9&right distal <CR>
A|forearm/leg portion ulnar nerve^^0.0001^10^ma<CR>
OBX|34|CM|95900.294090001&WAV|9|1~6~21~36~65~81~61~50~42~<CR>
A|31~10~1~-11~-46~-18~1~0~~~~~~~~~~~~~~~~~~~4~15~24~35~45~53~~52~~<CR>
⋮
OBX|44|CM|95900.294090004&ANA|3|1&TECH&CMAP&&&&19900324083422.7105^<CR>
A|3.41&ONLA&ms^10.81&PKAM&mv<CR>
OBX|45|CM|95900.294060001&TIM^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal arm or thigh site: sample number 1|13|19900324083502.8362^0.0001^<CR>
A|0.040^DNC<CR>
OBX|46|CM|95900.294060001&STM|13|^ECD^T-X9170-RGT-LC6&right distal arm/thigh<CR>
A| portion ulnar nerve^^0.0001^10^ma<CR>
OBX|47|CM|95900.294060001&WAV|13|1~5~3~2~1~0~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~4~15~24~35~45~53~~52~~<CR>
⋮
OBX|60|CM|95900.294060005&ANA|4|1&TECH&CMAP&&&&19900324083502.8362^<CR>
A|9.72&ONLA&ms^10.32&PKAM&mv<CR>
OBX|61|CM|95900&DST^Motor nerve conduction study|2|T-X9170-RGT-LC6&right <CR>
A|distal arm/thigh portion ulnar nerve^T-X9170-RGT-LC9&right distal forearm/leg <CR>
A|portion ulnar nerve^32.5<CR>
OBX|62|CE|1000.1^Temperature method||2^Digital probe^AS4&TMPM<CR>
OBX|63|NM|1000.5^Other temperature||36.2|CEL|35.5-38.|N<CR>
OBX|64|CE|1000.6^Other temperature source||T-14890-RGT-N1^<CR>
A|Right number 1 interosseous dorsales muscles^SNM+&TOPO<CR>
OBX|65|NM|95900.28826000010^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal arm or thigh site: CMAP amplitude||5.21|mv|3.8-21.4|N<CR>
OBX|66|NM|95900.28826000019^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal arm or thigh site: CMAP conduction velocity||52.0|m/s|>49|N<CR>
OBX|67|NM|95900.28826000015^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at distal <CR>
A|arm or thigh site: CMAP amplitude ratio||97.7|%|60-100|N<CR>
OBX|68|NM|95900.28829000013^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal forearm or leg site: CMAP latency||4.07|ms|2.3-4.6|N<CR>
OBX|69|NM|95900.28829000018^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor pollicis brevis muscle, at <CR>
A|distal forearm or leg site: CMAP ipsilateral reference nerve <CR>
A|latency difference||0.66|ms|<1.8|N<CR>
OBX|70|NM|95900.29406000010^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal arm or thigh site: CMAP amplitude||10.81|mv|6.3-16.0|N<CR>
OBX|71|NM|95900.29406000019^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal arm or thigh site: CMAP conduction velocity||51.5|m/s|>51|N<CR>
OBX|72|NM|95900.29406000015^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal arm or thigh site: CMAP amplitude ratio||95.5|%|80-100|N<CR>
OBX|73|NM|95900.29409000013^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal forearm or leg site: CMAP latency||3.41|ms|2.0-3.5|N<CR>
OBX|74|NM|95900.29409000018^Motor nerve conduction study, with electric <CR>
A|stimulation, recording from right abductor digiti minimi muscle of hand, <CR>
A|at distal forearm or leg site: CMAP ipsilateral reference nerve latency <CR>
A|difference||-0.66|ms|<2.0|N<CR>
OBX|75|TX|95900&GDT^Motor nerve conduction study|1|   Right median nerve <CR>
A|conductions were obtained, stimulating at the wrist and elbow, and <CR>
A|recording from the abductor pollicis brevis muscle.  Right ulnar nerve <CR>
A|conductions were obtained, stimulating at the wrist and elbow, and <CR>
A|recording from the abductor digiti minimi muscle.  CMAPs obtained <CR>
A|had normal amplitudes and distal latencies, and the calculated conduction <CR>
```

FIG. C-1 *(continued)*

```
A|velocities were within normal limits.  The median-ulnar distal latency <CR>
A|difference was also within normal limits.<CR>
OBX|76|TX|95900&MDT|1|   Normal right median and ulnar motor nerve <CR>
A|conductions.<CR>
OBX|77|CE|95900&DEV|1|^Nicolet Viking<CR>
OBX|78|ST|95900&SER|1|132546<CR>
OBX|79|CE|95900&ANT|1|T-X9170-RGT^Right ulnar nerve^SNM+&TOPO~<CR>
A|T-X9180-RGT^Right median nerve^SNM+&TOPO<CR>
OBX|80|CE|95900&IMP|1|1^Normal^AS4&MNCD|||N<CR>
OBR|2|5692^Neuro|2315^EMG|95904^Sensory nerve conduction study|<CR>
A||19900323151649|19900324084212|19900324084754|||G||^36 year old male with <CR>
A|6 month hx of tingling and pain in thumb, index, and middle finger of <CR>
A|right hand.  Rule out carpal tunnel syndrome.|||42678^Welby&Marcus&L&&Dr&<CR>
A|MD|444-2323|||||19900324101120||EN|F||||5692&Neuro^2314&EMG|||27384^Samson&<CR>
A|George&T&&Dr&MD|56372^Smith&Benjamin&S&&Dr&MD|^Kirk&Bonnie&P&&Ms|<CR>
A|^Quincy&Susan&R&&Ms<CR>
OBX|1|CM|95904&MTG^Sensory nerve conduction study|1|1^2<CR>
OBX|2|CM|95904&ELC|1|1&G1^T-X9180-RGT-LC9&right distal forearm/leg portion <CR>
A|median nerve^DT&Sn&0.4^0&PD~2&G2^T-X9180-RGT-LC9&right distal forearm/leg <CR>
A|portion median nerve^^-3.5&PD~3&G3^T-X9180-RGT-LC6&right distal arm/thigh <CR>
A|portion median nerve^ES&Sn&0.5^0&PD~4&G4^T-X9180-RGT-LC6&right distal <CR>
A|arm/thigh portion median nerve^^-3.5&PD<CR>
OBX|3|CM|95904&CHN|1|1^G1&G2^0.5&uv^^^-2048&2047^BP&ANA&32&6&3200&6~2^G3&G4<CR>
OBX|4|CM|95904.218500001&TIM^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right median nerve, palmar <CR>
A|branch: sample number 1|1|19900324084218.4837^0.0001^0.040^DNC<CR>
OBX|5|CM|95904.218500001&STM|1|^ECP^T-X9185-RGT&right median nerve, palmar <CR>
A|branch^^0.0001^10^ma<CR>
OBX|6|CM|95904.218500001&WAV|1|1^0~65~215~81~11~-110~-14~0~<CR>
A|~~~~~~~~~~-2~-12~15~80~45~15~-2~-12~-8~-2~0~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|^-1~^-4~^-6~^-4~^-1~^8~^12~^22~^31~<CR>
A|^40~^31~^22~^12~^8~^-1~^-4~^-6~^-4~^-1~^0~<CR>
⋮
OBX|13|CM|95904.218500004&TIM^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right median nerve, <CR>
A|palmar branch: sample number 4|4|19900324084231.6571^0.0001^0.040^<CR>
A|DNC^0^ALL^^4^0<CR>
OBX|14|CM|95904.218500004&STM|4|BEGIN^ECP^T-X9185-RGT&right median nerve, <CR>
A|palmar branch^0.5^0.0001^30^ma<CR>
OBX|15|CM|95904.218500004&WAV|4|1^0~260~860~244~44~-440~-56~0~<CR>
A|~~~~~~~~~~-8~-48~60~320~180~60~-8~-48~-32~-8~0~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|~~~~~~~~~~~~~^-4~^-16~^-24~^-16~^-4~^32~^48~^88~^124~^160~^124~^88~^48~^<CR>
A|32~^-4~^-16~^-24~^-16~^-4~^0~<CR>
⋮
A|~~~~~~~~~~~~~~~<CR>
OBX|16|CM|95904.218500004&ANA|1|1&TECH&SNAP&&&&19900324084231.6571^<CR>
A|1.80&ONLA&ms^160&PKAM&uv^2.16&PKLA&ms~2^6.95^80<CR>
OBX|17|CM|95904&DST^Sensory nerve conduction study|1|T-X9180-RGT-LC6&right <CR>
A|distal arm/thigh portion median nerve^T-X9180-RGT-LC9&right distal forearm/<CR>
A|leg portion median nerve^30.2<CR>
OBX|18|CM|95904&ELC|2|1&G1^T-X9170-RGT-LC9&right distal forearm/leg portion <CR>
A|ulnar nerve^DT&Sn&0.4^0&PD~2&G2^T-X9170-RGT-LC9&right distal forearm/leg <CR>
A|portion ulnar nerve^^-3.5&PD~3&G3^T-X9170-RGT-LC6&right distal arm/thigh <CR>
A|portion ulnar nerve^ES&Sn&0.5^0&PD~4&G4^T-X9170-RGT-LC6&right distal <CR>
A|arm/thigh portion ulnar nerve^^-3.5&PD<CR>
OBX|19|CM|95904.217400001&TIM^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch: sample number 1|5|19900324084357.3728^0.0001^0.040^DNC<CR>
OBX|20|CM|95904.217400001&STM|5|^ECP^T-X9174-RGT&right ulnar nerve, palmar <CR>
A|branch^^0.0001^10^ma<CR>
OBX|21|CM|95904.217400001&WAV|5|1^0~65~215~81~11~-110~-14~0~<CR>
A|~~~~~~~~-2~-12~15~80~45~15~-2~-12~-8~-2~0~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|^-1~^-4~^-6~^-4~^-1~^8~^12~^22~^31~<CR>
A|^40~^31~^22~^12~^8~^-1~^-4~^-6~^-4~^-1~^0~<CR>
⋮
OBX|31|CM|95904.217400005&TIM^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch: sample number 5|9|19900324084410.9362^0.0001^0.040^DNC^0^ALL^^4^0<CR>
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FIG. C-1 *(continued)*

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OBX|32|CM|95904.217400005&STM|9|BEGIN^ECP^T-X9174-RGT&right ulnar nerve, <CR>
A|palmar branch^0.5^0.0001^40^ma<CR>
OBX|33|CM|95904.217400005&WAV|9|1^0~260~860~244~44~-440~-56~0~<CR>
A|~~~~~~~~-8~-48~60~320~180~60~-8~-48~-32~-8~0~~~<CR>
A|~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~<CR>
A|^-4~^-16~^-24~^-16~^-4~^32~^48~^88~^124~<CR>
A|^160~^124~^88~^48~^32~^-4~^-16~^-24~^-16~^-4~^0~<CR>
⋮
A|~~~~~~~~~~~~~~~<CR>
OBX|34|CM|95904.217400004&ANA|2|1&TECH&SNAP&&&&19900324084410.9362^<CR>
A|1.60&ONLA&ms^140&PKAM&uv^1.92&PKLA&ms~2^6.93^70<CR>
OBX|35|CM|95904&DST^Sensory nerve conduction study|1|T-X9170-RGT-LC6&right <CR>
A|distal arm/thigh portion ulnar nerve^T-X9170-RGT-LC9&right distal forearm/<CR>
A|leg portion ulnar nerve^32.8<CR>
OBX|36|CE|1000.1^Temperature method||2^Digital probe^AS4&TMPM<CR>
OBX|37|NM|1000.5^Other temperature||35.8|CEL|35.5-38.|N<CR>
OBX|38|CE|1000.6^Other temperature source||T-14890-RGT-N1^<CR>
A|Right number 1 interosseous dorsales muscles^SNM+&TOPO<CR>
OBX|39|NM|95904.21856000019^Sensory nerve conduction study, recording orthodromically,<CR>
A| with electric stimulation of right median nerve, palmar branch, at distal <CR>
A|arm or thigh site: SNAP conduction velocity||58.6|m/s|>56|N<CR>
OBX|40|NM|95904.21856000015^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right median nerve, palmar <CR>
A|branch, at distal arm or thigh site: SNAP amplitude ratio||50.0|%|10-100|N<CR>
OBX|41|NM|95904.21859000010^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right median nerve, palmar <CR>
A|branch, at distal <CR>
A|forearm or leg site: SNAP amplitude||160|uv|>50|N<CR>
OBX|42|NM|95904.21859000012^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right median nerve, palmar <CR>
A|branch, at distal forearm or leg site: SNAP peak latency||2.16|ms|1.5-2.2|N<CR>
OBX|43|NM|95904.21859000018^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right median nerve, palmar <CR>
A|branch, at distal forearm or leg site: SNAP ipsilateral reference nerve <CR>
A|latency difference||0.24|ms|<0.2|H<CR>
OBX|44|NM|95904.21746000019^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch, at distal arm or thigh site: SNAP conduction velocity||61.5|m/s|<CR>
A|>55|N<CR>
OBX|45|NM|95904.21746000015^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch, at distal arm or thigh site: SNAP amplitude ratio||50.0|%|10-100|N<CR>
OBX|46|NM|95904.21749000010^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch, at distal forearm or leg site: SNAP amplitude||140|uv|>15|N<CR>
OBX|47|NM|95904.21749000012^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch, at distal forearm or leg site: SNAP peak latency||1.92|ms|1.5-2.2|N<CR>
OBX|48|NM|95904.21749000018^Sensory nerve conduction study, recording <CR>
A|orthodromically, with electric stimulation of right ulnar nerve, palmar <CR>
A|branch, at distal forearm or leg site: SNAP ipsilateral reference nerve <CR>
A|latency difference||-0.24|ms|<0.3|N<CR>
OBX|49|TX|95904&GDT^Sensory nerve conduction study|1|   Right median nerve <CR>
A|conductions were obtained, stimulating at the palm, and recording from the <CR>
A|wrist and elbow.  Right ulnar nerve conductions were obtained, stimulating <CR>
A|at the palm, and recording from the wrist and elbow.  SNAPs obtained had <CR>
A|normal amplitudes and distal latencies, and the calculated conduction <CR>
A|velocities were within normal limits.  However, the median-ulnar distal <CR>
A|latency difference was increased.<CR>
OBX|50|TX|95904&MDT|1|   Abnormal right median sensory nerve conduction, <CR>
A|indicative of a mild right median neuropathy at the wrist (carpal tunnel <CR>
A|syndrome).<CR>
OBX|51|CE|95904&DEV|1|^Nicolet Viking<CR>
OBX|52|ST|95904&SER|1|132546<CR>
OBX|53|CE|95904&ANT|1|T-X9180-RGT-LC9^Right distal forearm/leg portion <CR>
A|median nerve^SNM+&TOPO<CR>
OBX|54|CE|95904&IMP|1|618^Mildly increased SNAP ipsilateral reference nerve <CR>
A|latency difference^AS4&SNCD|||A<CR>
OBX|55|CE|95904&IMP|2|354.0^Carpal tunnel syndrome^I9C|||A<CR>
OBR|3|5692^Neuro|2316^EMG|95860^One extremity EMG with related paraspinals|<CR>
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FIG. C-1 *(continued)*

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A||19900323151649|19900324085008|19900324090548|||G||^36 year old male with <CR>
A|6 month hx of tingling and pain in thumb, index, and middle finger of <CR>
A|right hand.  Rule out carpal tunnel syndrome.|||42678^Welby&Marcus&L&&Dr&<CR>
A|MD|444-2323||||<CR>
A||19900324101122||EN|F||||5692&Neuro^2314&EMG|||27384^Samson&George&T<CR>
A|&&Dr&MD|56372^Smith&Benjamin&S&&Dr&MD|^Kirk&Bonnie&P&&Ms|<CR>
A|^Quincy&Susan&R&&Ms<CR>
OBX|1|CM|95860&MTG^One extremity EMG with related paraspinals|1|1^1<CR>
OBX|2|CM|95860&ELC|1|1&NDL^T-13882-RGT&right abductor pollicis brevis <CR>
A|muscle^NC&Pt&0.025&1&&SS&0.05&-1<CR>
OBX|3|CM|95860&CHN|1|1^NDL^1.0&uv^^^-2048&2047^BP&ANA&32&6&16000&6<CR>
OBX|4|CM|95860.28820001&TIM^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: sample number 1|1|<CR>
A|19900324085025.3825^0.0005^^DNC<CR>
OBX|5|CM|95860.28820001&ANA|1|&PHYS&&&&Insertional activity sample<CR>
OBX|6|CM|95860.28820001&WAV|1|39~543~-104~23~418~-35~260~864~-920~<CR>
A|450~80~460~-480~88~670~202~-90~-540~60~10~-680~601~36~-204~<CR>
A|605~440~-20~170~340~-424~-40~-30~28~380~-850~320~760~700~<CR>
⋮
A|634~82~-24~108~20~-883<CR>
OBX|7|CM|95860.28820002&TIM^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: sample number 2|2|<CR>
A|19900324085029.4630^0.0005^^DNC<CR>
OBX|8|CM|95860.28820002&ANA|2|&PHYS&&&&Spontaneous activity sample<CR>
OBX|9|CM|95860.28820002&WAV|2|39~543~-104~23~418~-35~260~864~-920~<CR>
A|450~80~460~-480~88~670~202~-90~-540~60~10~-680~601~36~-204~<CR>
A|605~440~-20~170~340~-424~-40~-30~28~380~-850~320~760~700~<CR>
⋮
A|634~82~-24~108~20~-883<CR>
OBX|10|CM|95860.28820003&TIM^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: sample number 3|3|<CR>
A|19900324085036.4835^0.0005^^DNC<CR>
OBX|11|CM|95860.28820003&ANA|3|&PHYS&&&&Voluntary activity sample<CR>
OBX|12|CM|95860.28820003&WAV|3|39~543~-104~23~418~-35~260~864~-920~<CR>
A|450~80~460~-480~88~670~202~-90~-540~60~10~-680~601~36~-204~<CR>
A|605~440~-20~170~340~-424~-40~-30~28~380~-850~320~760~700~<CR>
⋮
A|634~82~-24~108~20~-883<CR>
OBX|13|CM|95860.28820003&ANA|4|1&PHYS&MUP&&&&19900324085036.4835^<CR>
A|10.4&TODR&ms^0.4&PKDR&ms^0.38&PKAM&mv^7&FRQ&hz^3&NPHASE^<CR>
A|15&NTURN<CR>
OBX|14|CM|95860.28820003&WAV|4|39~543~-104~23~418~-35~260~864~-920~<CR>
A|450~80~460~-480~88~670~202~-90~-540~60~10~-680~601~36~-204~<CR>
A|605~440~-20~170~340~-424~-40~-30~28~380~-850~320~760~700~<CR>
⋮
A|634~82~-24~108~20~-883<CR>
OBX|15|CM|95860.28820003&ANA|5|1&PHYS&MUP&&&&19900324085036.4835^<CR>
A|10.8&TODR&ms^0.4&PKDR&ms^0.42&PKAM&mv^8&FRQ&hz^3&NPHASE^<CR>
A|17&NTURN<CR>
OBX|16|CM|95860.28820003&WAV|5|39~543~-104~23~418~-35~260~864~-920~<CR>
A|450~80~460~-480~88~670~202~-90~-540~60~10~-680~601~36~-204~<CR>
A|605~440~-20~170~340~-424~-40~-30~28~380~-850~320~760~700~<CR>
⋮
OBX|24|CM|95860&ELC^One extremity EMG with related paraspinals|2|1&NDL^<CR>
A|T-13981-RGT-N1&right number 1 dorsal interosseous muscles of hand^<CR>
A|NC&Pt&0.025&1&&SS&0.05&-1<CR>
OBX|25|CM|95860.29810001&TIM^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: <CR>
A|sample number 1|6|19900324085119.3820^0.0005^^DNC<CR>
OBX|26|CM|95860.29810001&ANA|6|&PHYS&&&&Insertional activity sample<CR>
OBX|27|CM|95860.29810001&WAV|13|39~543~-104~23~418~-35~260~864~-920~<CR>
A|450~80~460~-480~88~670~202~-90~-540~60~10~-680~601~36~-204~<CR>
A|605~440~-20~170~340~-424~-40~-30~28~380~-850~320~760~700~<CR>
⋮
OBX|66|CE|95860.28820000101^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: insertional activity <CR>
A|abundance||6^mildly increased^AS4&RELA<CR>
OBX|67|CE|95860.28820000211^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: fibrillation <CR>
A|potentials abundance||3^very rare^AS4&ABUN<CR>
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FIG. C-1 *(continued)*

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OBX|68|CE|95860.28820000231^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: fasciculation <CR>
A|potentials abundance||0^absent^AS4&ABUN<CR>
OBX|69|CE|95860.28820000021^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: motor unit <CR>
A|potentials activation||4^normal^AS4&RELA<CR>
OBX|70|CE|95860.28820000022^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: motor unit <CR>
A|potentials amplitude||6^mildly increased^AS4&RELA<CR>
OBX|71|CE|95860.28820000025^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: motor unit <CR>
A|potentials duration||4^normal^AS4&RELA<CR>
OBX|72|CE|95860.28820000026^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: motor unit <CR>
A|potentials complexity||6^mildly increased^AS4&RELA<CR>
OBX|73|CE|95860.28820000027^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: motor unit <CR>
A|potentials variability||4^normal^AS4&RELA<CR>
OBX|74|CE|95860.28820000024^One extremity EMG with related paraspinals, <CR>
A|recording from right abductor pollicis brevis muscle: motor unit <CR>
A|potentials recruitment||4^normal^AS4&RELA<CR>
OBX|75|CE|95860.29810000101^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: insertional <CR>
A|activity abundance||4^normal^AS4&RELA<CR>
OBX|76|CE|95860.29810000211^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: fibrillation <CR>
A|potentials abundance||0^absent^AS4&ABUN<CR>
OBX|77|CE|95860.29810000231^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: fasciculation <CR>
A|potentials abundance||0^absent^AS4&ABUN<CR>
OBX|78|CE|95860.29810000021^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: motor unit <CR>
A|potentials activation||4^normal^AS4&RELA<CR>
OBX|79|CE|95860.29810000022^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: motor unit <CR>
A|potentials amplitude||4^normal^AS4&RELA<CR>
OBX|80|CE|95860.29810000025^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: motor unit <CR>
A|potentials duration||4^normal^AS4&RELA<CR>
OBX|81|CE|95860.29810000026^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: motor unit <CR>
A|potentials complexity||4^normal^AS4&RELA<CR>
OBX|82|CE|95860.29810000027^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: motor unit <CR>
A|potentials variability||4^normal^AS4&RELA<CR>
OBX|83|CE|95860.29810000024^One extremity EMG with related paraspinals, <CR>
A|recording from right dorsal interosseous muscles of hand: motor unit <CR>
A|potentials recruitment||4^normal^AS4&RELA<CR>
OBX|84|CE|95860.27500000101^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: insertional activity <CR>
A|abundance||4^normal^AS4&RELA<CR>
OBX|85|CE|95860.27500000211^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: fibrillation potentials <CR>
A|abundance||0^absent^AS4&ABUN<CR>
OBX|86|CE|95860.27500000231^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: fasciculation <CR>
A|potentials abundance||0^absent^AS4&ABUN<CR>
OBX|87|CE|95860.27500000021^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: motor unit potentials <CR>
A|activation||4^normal^AS4&RELA<CR>
OBX|88|CE|95860.27500000022^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: motor unit potentials <CR>
A|amplitude||4^normal^AS4&RELA<CR>
OBX|89|CE|95860.27500000025^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: motor unit potentials <CR>
A|duration||4^normal^AS4&RELA<CR>
OBX|90|CE|95860.27500000026^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: motor unit potentials <CR>
A|complexity||4^normal^AS4&RELA<CR>
OBX|91|CE|95860.27500000027^One extremity EMG with related paraspinals, <CR>
```

FIG. C-1 *(continued)*

```
A|recording from right flexor carpi radialis muscle: motor unit potentials <CR>
A|variability||4^normal^AS4&RELA<CR>
OBX|92|CE|95860.27500000024^One extremity EMG with related paraspinals, <CR>
A|recording from right flexor carpi radialis muscle: motor unit potentials <CR>
A|recruitment||4^normal^AS4&RELA<CR>
OBX|93|CE|95860.23000000101^One extremity EMG with related paraspinals, <CR>
A|recording from right muscle of neck: insertional activity <CR>
A|abundance||4^normal^AS4&RELA<CR>
OBX|94|CE|95860.23000000211^One extremity EMG with related paraspinals, <CR>
A|recording from right muscle of neck: fibrillation potentials <CR>
A|abundance||0^absent^AS4&ABUN<CR>
OBX|95|CE|95860.23000000231^One extremity EMG with related paraspinals, <CR>
A|recording from right muscle of neck: fasciculation potentials <CR>
A|abundance||0^absent^AS4&ABUN<CR>
OBX|96|CE|95860.08820000101^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: insertional activity <CR>
A|abundance||4^normal^AS4&RELA<CR>
OBX|97|CE|95860.08820000211^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: fibrillation <CR>
A|potentials abundance||0^absent^AS4&ABUN<CR>
OBX|98|CE|95860.08820000231^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: fasciculation <CR>
A|potentials abundance||0^absent^AS4&ABUN<CR>
OBX|99|CE|95860.08820000021^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: motor unit potentials <CR>
A|activation||4^normal^AS4&RELA<CR>
OBX|100|CE|95860.08820000022^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: motor unit potentials <CR>
A|amplitude||4^normal^AS4&RELA<CR>
OBX|101|CE|95860.08820000025^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: motor unit potentials <CR>
A|duration||4^normal^AS4&RELA<CR>
OBX|102|CE|95860.08820000026^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: motor unit potentials <CR>
A|complexity||4^normal^AS4&RELA<CR>
OBX|103|CE|95860.08820000027^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: motor unit potentials <CR>
A|variability||4^normal^AS4&RELA<CR>
OBX|104|CE|95860.08820000024^One extremity EMG with related paraspinals, <CR>
A|recording from left abductor pollicis brevis muscle: motor unit potentials <CR>
A|recruitment||4^normal^AS4&RELA<CR>
OBX|105|TX|95860&GDT^One extremity EMG with related paraspinals|1|   EMG <CR>
A|examination of the right abductor pollicis brevis muscle demonstrated <CR>
A|mildly increased insertional activity and very rare fibrillation <CR>
A|potentials, and motor unit potentials had mildly increased amplitude and <CR>
A|were somewhat polyphasic.  EMG examination of the right first dorsal <CR>
A|interosseous, flexor carpi radialis, and paraspinal neck muscles, and EMG <CR>
A|examination of the left abductor pollicis brevis muscle, were normal.<CR>
OBX|106|TX|95860&MDT|1|   Abnormal EMG of right thenar muscle, indicative of <CR>
A|mild chronic denervation.  There is no evidence of a right cervical <CR>
A|radiculopathy, and the changes seen would be consistent with a right <CR>
A|median neuropathy at the wrist (carpal tunnel syndrome).<CR>
OBX|107|CE|95860&DEV|1|^Nicolet Viking<CR>
OBX|108|ST|95860&SER|1|132546<CR>
OBX|109|CE|95860&ANT|1|T-X9180-RGT-LC9^Right distal forearm/leg portion <CR>
A|median nerve^SNM+&TOPO<CR>
OBX|110|CE|95860&IMP|1|6110^Mildly increased abundance insertional activity^<CR>
A|AS4&EMGD|||A<CR>
OBX|111|CE|95860&IMP|2|3121^Very rare fibrillation potentials^AS4&EMGD|||A<CR>
OBX|112|CE|95860&IMP|3|626602^Mildly increased amplitude mildly increased <CR>
A|complexity motor unit potentials^AS4&EMGD|||A<CR>
OBX|113|CE|95860&IMP|4|354.0^Carpal tunnel syndrome^I9C|||A<CR>
P|3|4321098&8&M10|4321098&8&M10||Harvey^Jane^J^^Mrs||19600123|F|W|<CR>
A|214 First Street^Apt. 315^Hometown^IN^66667||445-3333Cday~445-4444Cevening|<CR>
A|53927^Jones&Thomas&L&&Dr&MD|||142^cm|55^kg|||||Right||OP|Neuro|||<CR>
A|M||||19900323<CR>
OBR|1|5683^Neuro|1235^EEG|95930^Visual evoked potential study|<CR>
A||19900323132546|19900324093532|19900324093858|||N||^30 year old female <CR>
A|with 2 week hx of blurred vision in right eye.  Rule out multiple <CR>
A|sclerosis.|||53927^Jones&Thomas&L&&Dr&MD|444-3666|||||19900324101203||EN|F|<CR>
```

FIG. C-1 *(continued)*

```
A|||||||97235^Berger&Hans&&&Dr|27593^Jones&Mary&S&&Dr&MD|^Quinlan&Daniel&S&&<CR>
A|Mr|^Quincy&Susan&R&&Ms<CR>
OBX|1|CM|95930.0&DST^Visual evoked potential study|1|T-10147&external <CR>
A|occipital protuberance (inion)^T-12171&frontonasal suture (nasion)^36~<CR>
A|T-Y0171-LFT&left preauricular area^T-Y0171-RGT&right preauricular area^36.5<CR>
OBX|2|CM|95930.0&MTG|1|1&Std VEP montage^4<CR>
OBX|3|CM|95930.0&ELC|1|1&Cz^T-Y0100&head^DC&Sn&0.4^0&TH^0&PH~2&Oz^^^90&TH^<CR>
A|270&PH~3&Iz^^^112.5&TH^270&PH~4&A1^^^120&TH^180&PH<CR>
OBX|4|CM|95930.0&CHN|1|1^Cz&A1^0.05&uv^^^-2048&2047^<CR>
A|BP&ANA&1&6&100&6~2^Oz&A1~3^Iz&A1~4^Oz&Cz<CR>
OBX|5|CE|95930.0&MED|1|^Diazepam 5 mg PO<CR>
OBX|6|CM|95930.01110001&TIM^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1|1|<CR>
A|19900324093532.7105^0.0005^0.250^DNC^0^ALL^^100^0<CR>
OBX|7|CM|95930.01110001&ANA|1|&TECH&&&&Left eye, std check size<CR>
OBX|8|CM|95930.01110001&STM|1|BEGIN^PRV^T-XX000-LFT&left eye^1.05^0.47619^<CR>
A|170^cd/m2^WHT^0.33^CHK^0.5^15<CR>
OBX|9|CM|95930.01110001&WAV|1|39^543^-104^23~418^-35^260^864~-92^5^<CR>
A|80^460~-1480^88^670^202~-90^-540^60^10~-680^601^36^-204~605^<CR>
A|440^-20^170~340^-424^-40^-30~28^380^-850^320~760^900^-60^68~<CR>
A|78^630^-1280^120~90^-7^984^382~-96^-1445^864^118~-642^94^27^<CR>
A|89~178^-683^58^-173~-53^664^510^-78~155^1780^90^-343~999^52^<CR>
⋮
A|634^82~1320^-12^134^-1331<CR>
OBX|10|CM|95930.01110001&ANA|2|2&TECH&N75&&&&19900324093532.7105^<CR>
A|84&PKLA&ms^3.8&PKAM&uv~4^82^5.2<CR>
OBX|11|CM|95930.01110001&ANA|3|2&TECH&P100&&&&19900324093532.7105^<CR>
A|108&PKLA&ms^4.0&PKAM&uv~4^108^5.66<CR>
OBX|12|CM|95930.01110001&ANA|4|2&TECH&N145&&&&19900324093532.7105^<CR>
A|137&PKLA&ms^2.6&PKAM&uv~4^137^3.12<CR>
OBX|13|CM|95930.01120001&TIM^Visual evoked potential study, full field checkerboard <CR>
A|pattern reversal stimuli to right eye: sample number 1|2|<CR>
A|19900324093624.1250^0.0005^0.250^DNC^0^ALL^^100^1<CR>
OBX|14|CM|95930.01120001&ANA|5|&TECH&&&&Right eye, std check size<CR>
OBX|15|CM|95930.01120001&STM|2|BEGIN^PRV^T-XX000-RGT&right eye^1.05^<CR>
A|0.47619^170^cd/m2^WHT^0.33^CHK^0.5^15<CR>
OBX|16|CM|95930.01120001&WAV|2|39^543^-10^23~418^-35^260^864~-92^4^<CR>
A|80^460~-1480^88^670^202~-90^-540^60^10~-680^601^36^-204~605^<CR>
A|440^-20^170~340^-424^-40^-30~28^380^-850^320~760^900^-60^68~<CR>
A|78^630^-1280^120~90^-7^984^382~-96^-1445^864^118~-642^94^27^<CR>
A|89~178^-683^58^-173~-53^664^510^-78~155^1780^90^-343~999^52^<CR>
⋮
A|634^82~1320^-12^134^-1331<CR>
OBX|17|CM|95930.01120001&ANA|6|2&TECH&N75&&&&19900324093624.1250^<CR>
A|77.5&PKLA&ms^3.2&PKAM&uv~4^76^4.2<CR>
OBX|18|CM|95930.01120001&ANA|7|2&TECH&P100&&&&19900324093624.1250^<CR>
A|101&PKLA&ms^2.5&PKAM&uv~4^103^4.58<CR>
OBX|19|CM|95930.01120001&ANA|8|2&TECH&N145&&&&19900324093624.1250^<CR>
A|126&PKLA&ms^3.1&PKAM&uv~4^131^4.93<CR>
OBX|20|CM|95930.01110002&TIM^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2|3|<CR>
A|19900324093715.2405^0.0005^0.250^DNC^0^ALL^^100^0<CR>
OBX|21|CM|95930.01110002&ANA|9|&TECH&&&&Left eye, large check size<CR>
OBX|22|CM|95930.01110002&STM|3|BEGIN^PRV^T-XX000-LFT&left eye^1.05^<CR>
A|0.47619^170^cd/m2^WHT^0.33^CHK^1.0^15<CR>
OBX|23|CM|95930.01110002&WAV|3|39^543^-104^23~418^-35^260^864~-92^<CR>
A|450^80^460~-1480^88^670^202~-90^-540^60^10~-680^601^36^-204~<CR>
A|605^440^-20^170~340^-424^-40^-30~28^380^-850^320~760^900^<CR>
A|-60^68~78^630^-1280^120~90^-7^984^382~-96^-1445^864^118~<CR>
A|-642^94^27^89~178^-683^58^-173~-53^664^510^-78~155^1780^90^<CR>
⋮
A|634^82~1320^-12^134^-1331<CR>
OBX|24|CM|95930.01110002&ANA|10|2&TECH&N75&&&&19900324093715.2405^<CR>
A|82&PKLA&ms^4.2&PKAM&uv~4^80^5.9<CR>
OBX|25|CM|95930.01110002&ANA|11|2&TECH&P100&&&&19900324093715.2405^<CR>
A|106&PKLA&ms^5.2&PKAM&uv~4^106^6.23<CR>
OBX|26|CM|95930.01110002&ANA|12|2&TECH&N145&&&&19900324093715.2405^<CR>
A|134&PKLA&ms^3.4&PKAM&uv~4^135^3.93<CR>
OBX|27|CM|95930.01120002&TIM^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2|4|<CR>
```

FIG. C-1 *(continued)*

```
A|19900324093802.5805^0.0005^0.250^DNC^0^ALL^^100^1<CR>
OBX|28|CM|95930.01120002&ANA|13|&TECH&&&&Right eye, large check size<CR>
OBX|29|CM|95930.01120002&STM|4|BEGIN^PRV^T-XX000-RGT&right eye^1.05^<CR>
A|0.47619^170^cd/m2^WHT^0.33^CHK^1.0^15<CR>
OBX|30|CM|95930.01120002&WAV|4|39^543^-10^23~418^-35^260^864~-92^0^<CR>
A|80^460~-1480^88^670^202~-90^-540^60^10~-680^601^36^-204~605^<CR>
A|440^-20^170~340^-424^-40^-30~28^380^-850^320~760^900^-60^68~<CR>
A|78^630^-1280^120~90^-7^984^382~-96^-1445^864^118~-642^94^27^<CR>
A|89~178^-683^58^-173~-53^664^510^-78~155^1780^90^-343~999^52^<CR>
⋮
A|634^82~1320^-12^134^-1331<CR>
OBX|31|CM|95930.01120002&ANA|14|2&TECH&N75&&&&19900324093802.5805^<CR>
A|75&PKLA&ms^4.1&PKAM&uv~4^73.5^4.9<CR>
OBX|32|CM|95930.01120002&ANA|15|2&TECH&P100&&&&19900324093802.5805^<CR>
A|99&PKLA&ms^3.5&PKAM&uv~4^101^5.21<CR>
OBX|33|CM|95930.01120002&ANA|16|2&TECH&N145&&&&19900324093802.5805^<CR>
A|124&PKLA&ms^4&PKAM&uv~4^123^5.78<CR>
OBX|34|NM|95930.0111000110^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 <CR>
A|stimulus rate||1.05|hz|1.05-1.05|N<CR>
OBX|35|NM|95930.0112000110^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 <CR>
A|stimulus rate||1.05|hz|1.05-1.05|N<CR>
OBX|36|NM|95930.0111000170^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 visual <CR>
A|pattern element size||0.5|deg|0.5-0.5|N<CR>
OBX|37|NM|95930.0112000170^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 visual <CR>
A|pattern element size||0.5|deg|0.5-0.5|N<CR>
OBX|38|NM|95930.0111000180^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 visual <CR>
A|field size||15|deg|15-15|N<CR>
OBX|39|NM|95930.0112000180^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 visual <CR>
A|field size||15|deg|15-15|N<CR>
OBX|40|NM|95930.0111000121^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 N75 <CR>
A|peak latency||84.0|ms|55-96|N||A^S<CR>
OBX|41|NM|95930.0112000121^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 N75 <CR>
A|peak latency||77.5|ms|55-96|N||A^S<CR>
OBX|42|CE|95930.0111000123^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 N75 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|43|CE|95930.0112000123^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 N75 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|44|NM|95930.0111000131^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 P100 <CR>
A|peak latency||108.0|ms|78-120|N||A^S<CR>
OBX|45|NM|95930.0112000131^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 P100 <CR>
A|peak latency||101.0|ms|78-120|N||A^S<CR>
OBX|46|NM|95930.0111000134^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 P100 <CR>
A|peak ipsilateral to contralateral latency difference||7.0|ms|<10|N||A^S<CR>
OBX|47|CE|95930.0111000133^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 P100 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|48|CE|95930.0112000133^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 P100 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|49|NM|95930.0111000141^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 1 N145 <CR>
A|peak latency||<CR>
A|137.0|ms|124-170|N||A^S<CR>
OBX|50|NM|95930.0112000141^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 N145 <CR>
A|peak latency||126.0|ms|124-170|N||A^S<CR>
OBX|51|CE|95930.0111000143^Visual evoked potential study, full field <CR>
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FIG. C-1 *(continued)*

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A|checkerboard pattern reversal stimuli to left eye: sample number 1 N145 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|52|CE|95930.0112000143^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 1 N145 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|53|NM|95930.0111000210^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 <CR>
A|stimulus rate||1.05|hz|1.05-1.05|N<CR>
OBX|54|NM|95930.0112000210^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 <CR>
A|stimulus rate||1.05|hz|1.05-1.05|N<CR>
OBX|55|NM|95930.0111000270^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 visual <CR>
A|pattern element size||1.0|deg|0.5-0.5|H<CR>
OBX|56|NM|95930.0112000270^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 visual <CR>
A|pattern element size||1.0|deg|0.5-0.5|H<CR>
OBX|57|NM|95930.0111000280^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 visual <CR>
A|field size||15|deg|15-15|N<CR>
OBX|58|NM|95930.0112000280^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 visual <CR>
A|field size||15|deg|15-15|N<CR>
OBX|59|NM|95930.0111000221^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 N75 <CR>
A|peak latency||82.0|ms|53-94|N||A^S<CR>
OBX|60|NM|95930.0112000221^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 N75 <CR>
A|peak latency||75.0|ms|53-94|N||A^S<CR>
OBX|61|CE|95930.0111000223^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 N75 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|62|CE|95930.0112000223^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 N75 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|63|NM|95930.0111000231^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 P100 peak
latency||106.0|ms|76-119|N||A^S<CR>
OBX|64|NM|95930.0112000231^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 P100 <CR>
A|peak latency||99.0|ms|76-119|N||A^S<CR>
OBX|65|NM|95930.0111000234^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 P100 <CR>
A|peak ipsilateral to contralateral latency difference||7.0|ms|<10|N||A^S<CR>
OBX|66|CE|95930.0111000233^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 P100 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|67|CE|95930.0112000233^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 P100 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|68|NM|95930.0111000241^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 N145 <CR>
A|peak latency||134.0|ms|122-167|N||A^S<CR>
OBX|69|NM|95930.0112000241^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 N145 <CR>
A|peak latency||124.0|ms|122-167|N||A^S<CR>
OBX|70|CE|95930.0111000243^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to left eye: sample number 2 N145 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|71|CE|95930.0112000243^Visual evoked potential study, full field <CR>
A|checkerboard pattern reversal stimuli to right eye: sample number 2 N145 <CR>
A|peak morphology||1^Normal^AS4&MRPH|||N<CR>
OBX|72|TX|95930.0&GDT^Visual evoked potential study|1|   The subject's <CR>
A|visual acuity was 20/20 OD and 20/20 OS with corrective lenses.  Pupils <CR>
A|were symmetric, visual fields intact by confrontation testing, and subject <CR>
A|was able to fixate well.~~   Pattern reversal visual evoked potentials <CR>
A|were obtained using a stimulus rate of 2.1 Hz and a total field size of 15 <CR>
A|degrees using both standard 30' check size and large 60' check size, for <CR>
A|each eye separately, recording referentially from vertex, occipital, and <CR>
A|inion electrodes (left ear reference), and recording from a bipolar <CR>
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FIG. C-1 *(continued)*

```
A|vertex-occipital derivation.  100 epochs were averaged.  The N75, P100, <CR>
A|and N145 peaks were well formed and had normal latencies and morphologies <CR>
A|at the occipital and inion sites.<CR>
OBX|73|TX|95930.0&MDT|1|   The pattern reversal visual evoked potentials are <CR>
A|normal bilaterally.  This does not exclude the possibility of <CR>
A|demyelinating disease.<CR>
OBX|74|CE|95930.0&DEV|1|^Nicolet Compact 4<CR>
OBX|75|ST|95930.0&SER|1|003465<CR>
OBX|76|CE|95930.0&ANT|1|3^Bilaterally^AS4&DIST<CR>
OBX|77|CE|95930.0&IMP|1|1^Normal^AS4&VEPD|||N<CR>
L|1||3|819723|19264<CR>
```

REFERENCES

(1) Microsoft Disk Operating System, Microsoft Corp.

(2) Ethernet LAN is a local area network system developed by Digital Equipment Corp., Intel Corp., and Xerox Corp.

(3) Transmission Control Protocol/Internet Protocol (TCP/IP), Comer, D., *Internetworking with TCP/IP: Principles, Protocols, and Architecture,* Prentice-Hall, Englewood Cliffs, NJ 07632.

(4) *International Classification of Diseases,* 9th revision, Clinical Modification, 3rd edition, 1989, available from Commission on Professional and Hospital Activities, 1968 Green Rd., Ann Arbor, MI 48105.

(5) *Physicians' Current Procedural Terminology,* 2007 edition, available from American Medical Association, P.O. Box 10950, Chicago, IL 60610.

(6) *Systemized Nomenclature of Medicine,* 2nd edition Vols 1,2, 1984, available from College of American Pathologists, 5202 Old Orchard Road, Skokie, IL 60077.

(7) Unicode: The Unicode Worldwide Character Set Standard, Version 1.0.1 (1992), Addison Wesley, Vol I, 1991; Vol II, 1992.

(8) Health Care Financing Administration, U.S. Dept of Health and Human Services, Bureau of Program Operations, 6325 Security Blvd., Meadows East Bldg., Room 300, Baltimore, MD 21207.

(9) INTDIS (International Drug Information System), World Health Organization Collaborating Centre for International Drug Monitoring, P.O. Box 26, S-751 03, Uppsala, Sweden.

(10) Universal Medical Device Nomenclature System, available from ECRI, 5200 Butler Pike, Plymouth Meeting, PA 19462.

(11) International Classification of Sleep Disorders Diagnostic and Coding Manual, 1990, available from American Sleep Disorders Association, 604 Second Street SW, Rochester, MN 55902.

(12) Kemp B, Varri A, Rosa A, Nielsen K, Gade J. A simple format for exchange of digitized polygraphic recordings. *Electroenceph Clin Neurophyiol* 1992;**82**:391-393.

(13) Kemp B, Olivan J. European data format 'plus' (EDF+), an EDF alike standard format for the exchange of physiological data. *Clin Neurophysiol*. 2003 Sep;**114**(9):1755-61.