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An American National Standard

Standard Specification for Transferring Digital Neurophysiological Data Between Independent Computer Systems[1]

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1. Scope

1.1 This specification 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 specification is concerned primarily with electroneurophysiology, 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 specification defines a format for waveform data based on Specification E 1238 (developed in cooperation with HL7 (Health Industry Level 7)), with extensions to support the transmission of multichannel time-series waveforms.

1.3 This specification 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.

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. An example suitable for transmission of large amounts of digital waveform data would be the use of industry-standard magnetic tape or digital audio tape (DAT), with ANSI standard tape labels, employing variable length blocked records (lines) with a maximum block size of 4092 bytes. Individual lines within the blocks would be terminated by carriage return characters, Code 13 in the American Standard Codes for Information Interchange (ASCII). As another example, for the transmission of moderate amounts of digital waveform data, floppy disks written in MS-DOS **(1)**[2] format (or another commonly used directory and file structure) would be appropriate; 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.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this specification.

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2. Referenced Documents

2.1 *ASTM Standards:*

E 1238 Specification for Transferring Clinical Observations Between Independent Computer Systems[3]

2.2 *ANSI Standards:*

X3.4-1986 Coded Character Sets—American National

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

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 Standard:*

Health Industry Level 7 Interface Standards[6]

3. Significance and Use

3.1 *General Approach*:

3.1.1 This specification 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 specification 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 specification. 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 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 specification 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 specification over a wide range of applications, various levels of implementation are defined. Applications of this specification may range from simple embedded controllers in instrumentation at the most basic level, to integrated laboratory information systems at the higher levels. Simple implementations may evolve into more fully featured systems as needs arise. 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 Specification E 1238 (or, alternatively, HL7) 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

[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.

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 specification 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 X2). 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 specification 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 specification 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 specification 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 Specification E 1238 and HL7 Standards*:

4.1.1 This specification is primarily based on Specification E 1238. All requirements of Specification E 1238 must be adhered to by implementations of *this* specification, except where specifically noted herein. Specification E 1238 defines some features (such as data types, information categories, and code tables) which are not mentioned in this specification; if any of these features are applicable, they may be used by a system which implements *this* specification.

4.1.2 Although the message format defined by Specification E 1238 is the recommended standard and portable format for applications which use this specification for transferring electrophysiologic data (including digitized waveforms) between independent computer systems, some systems or institutions which already implement the HL7 message protocol may wish to embed their electrophysiologic data instead within an HL7 message. Since Specification E 1238 OBR (order) and OBX (result) segments are essentially identical to the HL7 OBR and OBX segments, orders for electrophysiologic studies as well as the results (observations) from those studies can be transmitted within an HL7 formatted message instead of a Specification E 1238 formatted message. In this case, the HL7 message types such as ACK (general acknowledgment), ORF (observation result, response to query), ORM (order), ORR (order response), ORU (observation result, unsolicited), QRY (query), etc., as well as the HL7 segment types such as EVN (event type), MSA (message acknowledgment), MSH (message header), NTE (notes and comments), ORC (common order), PID (patient identification), PV1 (patient visit), QRD (query definition), QRF (query filter), etc., defined in the HL7 document are used in place of the Specification E 1238 message format and segment types such as H (message header), P (patient identification), E (error checking), C (comment), Q (query), and L (message terminator) described in this specification.

4.1.3 While Specification E 1238 is concerned only with the transfer of clinical provider and diagnostic service orders and results (observations), HL7 is concerned with all information services within a hospital network (including admission/

discharge/transfer, billing, pharmacy orders, and other functions); the HL7 message structure is correspondingly more complex and general and may involve additional processing overhead (for example, all HL7 messages transmitted over the network must be acknowledged). Although the message and segment formats differ (aside from OBR and OBX segments), many of the data fields and their formats are similar between the two standards. Thus, in institutions which need to use HL7 for networked communications between most institutional computer systems, but want to use the simpler Specification E 1238 format for communications among a limited number of laboratory computer systems, a *gateway* system which translates HL7-formatted order messages to Specification E 1238 format and Specification E 1238 formatted result messages to HL7 format would be relatively easily implemented.

4.1.4 This specification, like Specification E 1238 and HL7, 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. Future versions of this specification will make these distinctions more formal to permit the use of alternative encoding rules to represent the specification's logical content.

4.2 *Extensions to Specification E 1238 and HL7 Standard Formats*—This specification defines several minor extensions to these standards, as described as follows. The use of these extensions in data transmissions is optional; a transmitting system which implements this specification may choose to send data in a format which is entirely compatible with Specification E 1238 and HL7 standards, but a receiver system must be able to accept transmissions that use these extensions when appropriate, in order to be considered compatible with this specification.

4.2.1 *Specifying Information Categories in OBR and Q Segments*—This specification 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 Specification E 1238 request results (Q) segment test/observation ID field. Although this capability is currently not explicitly stated in the Specification E 1238 and HL7 standards, 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 specification extends the Specification E 1238 and HL7 standards 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 Specification E 1238 and HL7 standards explicitly allow 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 specification 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 specification 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 specification 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 specification because they are not relevant to Specification E 1238 formatted messages.

4.2.5 *Subject Filter and Qualifiers Field in Q Segments*—This specification 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 Specification E 1238 for arbitrary use by the requesting (querying) system.

4.3 *Message Characteristics and Terminology*—Specification E 1238 and the HL7 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 (bell), 9 (tab), 10 (linefeed), 11 (vertical tab), and 12 (formfeed), with ASCII 13 (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 languages, and at this time it would be the recommended character set for implementations of this specification in countries which use European languages and need to conveniently and compactly represent characters other than those defined in ANSI X3.4-1986. Also, certain systems may need to transmit waveform data in a nonstandard format for efficiency reasons, and may use the \Zdddd\ escape sequence for this purpose with 8-bit characters included in the sequence (for example, when transmitting *binary* data). 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 specification 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 × 0202 in order to mix Kanji and ASCII characters). Either of these methods could be used in implementations of this specification 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 specification, *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 Specification E 1238 message; see the HL7 document for allowed segment types in an HL7 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 ^(caret); 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 specification. 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 specification 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 addenda line). This specification 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 specification 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 specification, receiving systems *may* be designed to process more characters than the currently specified maxima.

4.3.7 *Maximum Line Length*—Specification E 1238 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 addenda 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 a Specification E 1238 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 specification need not be designed to accept lines longer than 220 characters. HL7 does not define maximum line lengths and HL7 messages do not use addenda lines.

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 Specification E 1238, Tables 26 (ANSI) and 25 (ISO). This specification 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 specification. New units may be created by prefixing a multiplier to a basic unit (for example, uv = 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, $uv2 = \mu V^2$ = 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 Specification E 1238 or HL7 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 specification, along with the Specification E 1238 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:

<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 specification, 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 1; refer to Specification E 1238 for a complete list. The default coding system and code table depends on the nature of the CE format field. For diagnostic impressions, the default is **I9C**. For anatomic localizations, the default is **SNM+&TOPO**, except when used in a result segment transmitting an anatomic localization (distribution) as an individual test result, for which the default is **AS4&DIST**. For test/observation IDs, the default is **AS4&TEST**. For individual qualitative test results or findings, the default is **AS4&xxxx**, where the specific code table identifier *xxxx* depends on the individual test, which is determined by the test/observation ID (see Appendix X2). 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 Specification E 1238 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,

TABLE 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	Specification E 1467 universal diagnosis codes, defined in Appendix X2 (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 X1 (specific code table identifier **TOPO**).
AS4	Specification E 1467 universal anatomic distribution (localization) codes, defined in Appendix X2 (specific code table identifier **DIST**).
Test/Observation ID Coding Systems	
AS4	Specification E 1467 universal test/observation ID codes, defined in Specification E 1238 and in Appendix X2 (specific code table identifier **TEST**).
C4	CPT-4 (Physicians' Current Procedural Terminology, 4th edition) test codes.
Individual Test Result Coding/Grading Systems	
AS4	Specification E 1467 universal test result codes, defined in Appendix X2 (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/HCFA's universal producer numbers (unique codes for each medical facility or laboratory in the United States).
UPIN	Medicare HCFA'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.

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., HCFA's universal physician codes **(8)**, 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 specification. 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 specification; note, however, that future versions of this specification 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 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 is used to uniquely identify data which is stored on another system using a pointer to that data. An RP type field consists of three components separated by component delimiters (^), as follows:

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

The first component is a unique key or address assigned by the system on which the data is stored, and may be used to identify and access the data. The second component specifies the unique name (up to six characters in length) of the system on which the data is stored (like the sender ID and receiver ID fields in the message header segment); these names must be unique within a given set of systems which communicate using the E1467 message format. The third component is a code identifying the type of data stored and may be one of the following codes, or another code that has meaning to both the sending and receiving systems (the last of these codes is not defined by Specification E 1238, but is a Specification E 1467 extension):

SI = scanned image
SD = scanned document
TX = *machine-readable* text
FT = formatted text
WV = digitized waveform data

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 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 Specification E 1238 and HL7 standards 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 The HL7 standard defines an alternative data type to TX known as formatted text (FT), which differs from TX in that repeat delimiters are not allowed for formatting, but instead special formatting commands (analogous to word processor directives) enclosed in escape characters (\) may be included (see the HL7 document for details); this data type may be used in place of TX in HL7-formatted messages but not in messages formatted in accordance with Specification E 1238.

4.5 *Segment Types*—Table 2 lists the Specification E 1238 segment types (plus the MSA segment added by this specification), the defined fields of each segment, and their data type, requirement status, and maximum lengths. Only the fields of

those Specification E 1238 segments of most interest to neurophysiology are listed in Table 2; refer to Specification E 1238 for a complete list of fields for all segments. The segment types and data fields defined by HL7 are not listed in Table 2; refer to the HL7 document for more information. In Table 2, 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 Specification E 1238 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 specification (and regardless of implementation level), a receiving system should be able to accept values for all fields and all segment types defined by this specification and by Specification E 1238 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 mostgeneral receiving systems should not require the presence of these fields. The following briefly describes Specification E 1238 segment types and their fields; refer to Specification E 1238 for detailed information on each segment and field type.

TABLE 2 Synopsis of Specification E 1238 Segments and Field Names

Mnemonic	Field Name	Type	Required	Length, max
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
General Test/Observation Master Segment (OM1)				
(The OM1 segment fields are defined in Specification E 1238)				
Numeric Test/Observation Master Segment (OM2)				
(The OM2 segment fields are defined in Specification E 1238)				
Categorical Test/Observation Master Segment (OM3)				
(The OM3 segment fields are defined in Specification E 1238)				
Test/Observation Master Segment for Observations Requiring Specimens (OM4)				
(The OM4 segment fields are defined in Specification E 1238)				
Test/Observation Master Segment for Observation Batteries (OM5)				
(The OM5 segment fields are defined in Specification E 1238)				
Test/Observation Master Segment for Calculated Observations (OM6)				
(The OM6 segment fields are defined in Specification E 1238)				
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
Guarantor Segment (GT1)				
(The GT1 segment fields are defined in Specification E 1238)				
Insurance Segment (IN1)				
(The IN1 segment fields are defined in Specification E 1238)				
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

TABLE 2 *Continued*

Mnemonic	Field Name	Type	Required	Length, max
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)	(variable)	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 units	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

TABLE 2 *Continued*

Mnemonic	Field Name	Type	Required	Length, max
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
Scientific Segment (S)				
(The S segment fields are defined in Specification E 1238)				
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

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 specification and *x* is a number which identifies the particular version of this specification; the version number *E.2* 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 3. 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

TABLE 3 Acknowledgment Codes

Code	Meaning
AA	Application Accept
AE	Application Error
AR	Application Reject

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 specification.

4.5.3 *Test/Observation Master Segments (OM1–OM6)*—These six optional segments may be transmitted by a diagnostic (laboratory) service to its *clients* to inform them about the observations and observation batteries or functional procedures (tests) performed by the diagnostic service (producer). The transmission of a message containing test/observation master segments may be either unsolicited (for example, when the laboratory adds new observations or changes the format, technique, or interpretation of existing observations or procedures) or may occur in response to a query sent by the *client* system. See Specification E 1238 for a complete description of the OM1–OM6 segments and their formats.

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 Specification E 1238 for possible values), patient's language, patient's confidentiality status (see Specification E 1238 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 *Billing Segments (GT1 and IN1)*—These two optional segments may be used in a message used to electronically order an electrophysiolgic test to transmit billing information needed by the producer (laboratory). The GT1 segment identifies a person (guarantor) and the IN1 segment identifies an insurance company and plan that may be billed for the study. Multiple GT1 or IN1 segments, or both, may be transmitted in a contiguous sequence when multiple guarantors and insurance plans apply. These segments apply to all of the orders that follow until superseded by another set of GT1 and IN1 segments or a new P (patient identifying) segment. See Specification E 1238 for detailed information about the format and usage of these segments.

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 transmissionsystem); 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 Specification E 1238 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 Specification E 1238 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, request, or scientific segments. It may be used, for example, to specify additional detail about electrodes, channels, filters, stimulus paradigms, analysis results, etc., which cannot be expressed in the currently defined field structure of result (OBX) segments. It is not to be used for technical comments (often technician generated) related to the behavior of the subject or events during the performance of the electrophysiologic procedure itself (the TCM 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