

PETROLEUM INDUSTRY DATA EXCHANGE

**Conventions and Implementation
Guidelines for EDI**

**WELLSITE
INFORMATION
TRANSFER
SPECIFICATION

(WITS)**

Version 1.1 July 1991

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SECTION 1 : INTRODUCTION

The WELLSITE INFORMATION TRANSFER SPECIFICATION (WITS) is a communications format used for the transfer of a wide variety of wellsite data from one computer system to another. It is presented as a recommended format by which Operating and Service companies involved in the Exploration and Production areas of the Petroleum Industry may exchange data in either an online or batch transfer mode.

WITS is a multi-level format which offers an easily achieved entry point with increasingly flexible higher levels. At the lower levels, a fixed format data stream is employed, while, at higher levels, a self-defining customizable data stream is available.

A WITS data stream consists of discrete data records. Each data record type is generated independently of other data record types and each has a unique trigger variable and sampling interval. The rig activity usually determines which records are applicable at any given time such that only appropriate data is transmitted.

WITS also incorporates the means for a remote computer system to send instructions to the sending system in order to set or change certain parameters, including the type of data transmitted and the interval for transmission.

As well as specifying a format for data transmission, WITS also defines a basic set of record types to which user-defined record types may be added.

Background

Over the years many Operating and Service companies have developed proprietary formats for electronic data exchange. When a new working relationship is established between a Service company and an Operator, new software may need to be written, followed by extensive testing and debugging before the data collection and analysis systems of the two entities can communicate with one another correctly. This often leads to problem start-ups with the resulting loss of time and data. The ongoing development and maintenance of these formats represents a significant expenditure.

The cost and complexity of format matching and modification has often led to a reluctance on the part of some Operators to get involved in this type of service, and a great deal of rig data, which could be extremely useful in rig performance evaluation, drilling monitoring and control, and formation evaluation while drilling, is often not collected or readily available to decision makers.

In an attempt to resolve this information transfer problem, the Rig Instrumentation and Measurement (RIM) subcommittee of the International Association of Drilling Contractors (IADC) formed a task group, the Information Transfer subcommittee.

Information Transfer subcommittee

The Information Transfer subcommittee consisted of Operating and Service company representatives working in the areas of computer software system development, geology and drilling engineering. All were familiar with the problems associated with the profusion and mismatch of rig data formats.

To ensure that any format proposed was both complete and acceptable to the industry as a whole, a vigorous effort was made to involve representatives from as many Operating and Service companies as possible. This effort included correspondence with companies operating in Europe and Asia as well as the United States.

The goal of the work group was broad but concrete:

"To define the format and information content of the data stream transmitted from a wellsite to a central site by telecommunications facilities or hard media".

To minimize omissions in the format, a major effort was made to obtain an inventory of data items monitored or collected at the wellsite in the following areas:

- Geology
- Drilling and Engineering
- Measurement-While-Drilling (MWD)
- Rig Parameters
- Cementing
- Drill Stem Testing

Companies providing data collection services in these areas were polled for data items and formats currently in use. Concurrent with the effort, the group's members familiarized themselves with the major existing formats and data transmission systems in use in the industry. A seminar, widely attended by an excellent cross-section of the industry, presented information on general methods of data transmission and formatting, different hardware/software systems currently in use, and the nature and content of several specific formats. The seminar was reinforced by site visits and presentations at data centers operated by Amoco, Arco, Mobil, and Tenneco.

With a comprehensive data dictionary established and with representatives on the subcommittee familiar with existing formats, careful consideration led to a set of requirements which, it was hoped, would satisfy the present and future needs of both Operating and Service companies.

Among these requirements were:

- achievable by both small and large companies
- adaptable to the needs of the industry over the course of time as technology changes
- offer a simple, low cost entry point
- limit long term software support costs
- employ an efficient mode of transmission
- be capable of use in both online and in batch modes
- be capable of implementation on a wide range of computer platforms
- meet the needs of both the single remote user and the multi-rig data center
- encompass existing standards (official or "de facto") where possible
- address international as well as domestic needs

With these requirements in mind, the subcommittee adopted the Log Information Standard (LIS) as the basic framework for WITS and set about formulating the specific components of the format. LIS was chosen since it met many of the requirements set out for WITS and is a well established and familiar method of data exchange (a "de facto" standard in the wireline industry). The result of this work is the WITS data communications format described in this document.

The Information Transfer subcommittee evolved into the Wellsite Information Transfer Steering Group and, in addition to its status as a subcommittee of IADC, the WITS Steering Group is also an active member of the API Petroleum Information Data Exchange (PIDX). The API-PIDX WITS User Group exists to promote the format, respond to questions of interpretation, and to investigate ways of enhancing the format to meet new requirements in the future.

Wellsite Information Transfer Specification

A major feature of WITS is its multi-level approach in providing communications functionality. There are four currently defined levels with level 0 based on an ASCII format and levels 1 through 3 based on LIS, each representing an increase in complexity and flexibility. A fifth level (WITS Level 4) is currently under consideration by the subcommittee and will likely take advantage of the newly approved API RP-66 (DLIS) format as its framework. This will allow for a very high degree of flexibility but with an accompanying degree of complexity. This document confines itself to discussion of the WITS levels 0 through 3 and leaves Level 4 for a future revision.

The basic unit of transfer in WITS (as in LIS) is the "physical record" (Figure 1.1). In turn, the physical record envelopes a "logical record". While LIS consists of many types of logical record, only a few are used in WITS, with different levels of implementation employing specific types.

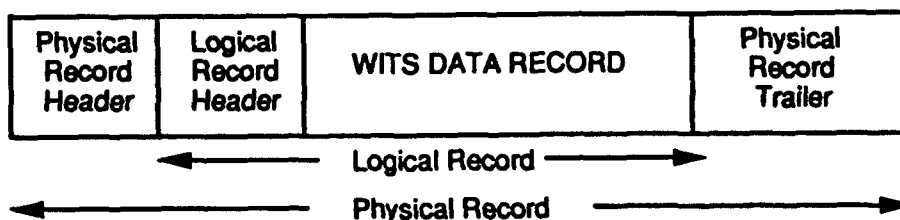


Fig. 1.1 : Structure of a WITS Data Record

The basic logical record type used in WITS is the Data Record. Each Data Record consists of a group of related Data Items (fields or channels). While LIS is a self defining format, using Data Format Specification (DFS) records to describe the content of subsequent data records, the subcommittee felt that a basic set of "Pre-Defined Data Records" would serve as a good entry point into the format and meet the needs of a large number of Operators, as well as cut down the development time which would be required for a more complex system. Level 3 allows the user to employ custom record types through the use of DFS records.

The WITS Levels currently specified (from simple to complex) are:

WITS Level 0

Level 0 of WITS consists of the unidirectional transfer of ASCII format data values from one computer system to another. The primary intent of this level is to provide a simple method for Service companies to exchange data at the wellsite. This might be desirable if, for example, there is only one communications channel available for data transfer off the wellsite, but where data from more than one vendor is required. This also provides an easy entry point for less demanding remote transmission requirements.

WITS Level 1

Level 1 consists of the unidirectional transmission of Data Records made up of a fixed format and content. These records are termed WITS Pre-Defined Data Records and their content is described in Appendix A. This level comprises LIS Data Records only. No other LIS logical record types are used and no bidirectional dialogue takes place.

The only permitted modification to the Pre-Defined Records is the replacement of designated SPARE channels with other data items. The records to be sent and their transmission intervals must be agreed upon in advance and can only be changed by the SENDER.

WITS Level 2

Level 2 of WITS also uses Pre-Defined Data Records but incorporates bidirectional dialogue which permits the remote system (RECEIVER) to control various aspects of the communication session. These commands are sent within LIS Comment (type 232) logical records. Thus, at this level, LIS Data and Comment records are used. As with Level 1, data record modification is limited to the replacement of SPARE channels with other data items. The buffering of data records by the SENDER and their subsequent availability for retransmission or batch transfer, is optional at this level.

WITS Level 3

Level 3 provides for Custom Data Records in addition to Pre-Defined Data Records. Such records must be identified in advance of their use through the transmission by the SENDER of a Data Format Specification Record (LIS Logical Record type 64) for each Data Record giving details of the record's content. This level represents a very flexible format for data transfer. It does, however, mean added complexity, especially for the RECEIVER who must be able to read the Data Format Specification Record in order to interpret the content of custom data records if they are being used. The Pre-Defined Data Records are records 1 through 25 (LIS Logical Record type 151 through 175). WITS Data Records 26 through 49 (type 176-199) are reserved for future definition by the Steering Group, while custom WITS Data Records may be 50 through 80 (type 200 through 230). The buffering of data records by the SENDER is mandatory at this level.

Implementation of WITS

An important factor which greatly affects implementation is whether the user is an Operator or Service company. Normally, Service companies will be gathering and transmitting the wellsite data. Their systems will usually be SENDERS. Similarly, for the most part, Operators will be receiving and processing the transferred data and their systems will usually be RECEIVERS. In some cases a company may need to develop both SENDER and RECEIVER software.

An implementor of WITS should be familiar with this document and the LIS manual (Reference 2). The subcommittee will assist new developers in the areas of clarification and interpretation of the format. It is extremely important that WITS levels are implemented fully. If a particular level of WITS is to be used, then 100% of that level should be implemented. This includes the handling of both sets of specified units. Partial level implementations will only serve to invalidate the goals being strived for by the development of this format.

WITS Compliancy

The following guidelines should be used when stating the level of WITS supported by a particular system:

- WITS Level 0 (state whether SENDER, RECEIVER or BOTH and which records are supported if not ALL)
- * WITS Level 1 (state whether SENDER, RECEIVER or BOTH and which records are supported if not ALL)
- * WITS Level 2 (state whether SENDER, RECEIVER or BOTH, which records are supported and whether a buffer is used (Level 2B).
- * WITS Level 3 (state whether SENDER, RECEIVER or BOTH)

Advantages of using the WITS format

1. WITS defines data content and format agreed upon and reviewed by Service companies of a range of specialties as well as many major Operators.
2. WITS permits a range of communication options from simple unidirectional data transfer of a subset of well-defined records to fully bidirectional communication sessions.
3. WITS creates a means by which Operator and Service companies can interface without inefficient outlays of capital investment for software to support incompatible transmission formats.
4. WITS provides a "common language" in the field of data transfer at and from the wellsite.

About this document

In the development of WITS, the concepts of the ISO/OSI (International Standards Organization/Open Systems Interconnect) model were studied (Reference 1). Figure 1.2 illustrates the various layers of the ISO/OSI model and where WITS fits into the structure.

Section 2 presents the Data Format or, roughly, the "session" layer aspects of WITS, including the format of the data stream as well as example transmission sessions at all WITS Levels.

Section 3 presents the Data Content, analogous to the "presentation" layer. Data Record structure is explained and the Pre-Defined Data Records are described.

ISO MODEL LAYERS		WELLSITE INFORMATION TRANSFER SPECIFICATION (WITS)
7	APPLICATION	NON WITS
6	PRESENTATION	
5	SESSION	WITS DATA RECORDS BIDIRECTIONAL DIALOGUE
4	TRANSPORT	
3	NETWORK	NON WITS ERROR DETECTION ERROR CORRECTION ENCRYPTION PHYSICAL SYNCHRONIZATION
2	DATA LINK	
1	PHYSICAL	

Figure 1.2 Relationship of WITS to the ISO/OSI Model

Section 4 describes commands used in the bidirectional session dialogue of WITS. Since these are used in Level 2 and 3, implementors of Level 0 and Level 1 can safely ignore these commands.

Section 5 contains Implementation guidelines for data handling and processing. This includes notes on averaging, synchronization of transmitted records, and buffering.

The Appendices contain the details of the Specification, including the format and content of the Pre-Defined Data Records and Data Dictionary mnemonics.

Also included in the Appendices is a discussion of some of the Communications Hardware and "transport" layer questions which were addressed during the formulation of WITS which, though not part of the software specification, may help in the Implementation of a practical data communications system.

SECTION 2: DATA FORMAT

Introduction

This section describes the encapsulation of WITS formatted data within LIS physical and logical records. Only extensions or constraints imposed on LIS for use within the WITS format are described. The document does not attempt to fully describe the LIS format. The reader is directed to Reference 2 for full details of LIS including the format of the various numerical representation codes used in WITS.

The intent of this "WITS-compliant LIS" is to provide the features required for the transfer of digital rigsite data in "realtime" and batch mode, and to facilitate the development and implementation of WITS by constraining the flexibility of LIS where it is not required for typical wellsite data communications.

WITS-compliant LIS

The following are restrictions and modifications to LIS when used in WITS.

Physical Records

1. Maximum length of 1024 bytes.
2. Physical Record Trailer must be present for all records.
3. Since File Number and Record Number, as recorded in the Physical Record Trailer, have no real meaning in a WITS setting, the four bytes reserved in the trailer for these items is taken up by a new item, termed the Physical Record Trailer Sequence Number. This is a unique identifier assigned to successive WITS Data Records and is a 32 bit unsigned integer (with representation code 129, a 32 bit unsigned integer). NOTE that this applies only to WITS Data Records, not to LIS Comment Records or LIS Data Format Specification Records which should contain 0 for File Number and Record Number.
4. A WITS checksum, type 3 (defined in Figure 2.1) is required in all WITS records.
5. Physical Record Header must have Bits 18, 19, 21 and 22 turned ON to indicate these Physical Record Trailer attributes.
6. Bit 23 of the Physical Record Header (undefined in LIS) is used to indicate whether a data record has been transmitted in "realtime" (bit OFF) or from a buffer (bit ON) at some later time.

NOTE: throughout the document, the term "realtime" refers to a record which is transmitted at it's appropriate triggering time (i.e. at time of generation), while the term "buffered" refers to a record which must be reloaded from mass storage for transmission at some time after it was generated.

Logical Records

1. Have a maximum size of 1014 bytes meaning that a WITS logical record does not consist of more than one physical record.
2. The normally unused second byte of the Logical Record Header is used to indicate the triggering stimulus for the record. NOTE: This is a binary value rather than an ASCII character in the byte. The following codes are used:

Time	1
Depth	2
Event	3
Manually triggered by SENDER	4
Polled by RECEIVER	10 + one of above if applicable

For example : a record triggered on a time basis would have 0000001 (decimal 1) in this byte, while a record polled by the RECEIVER but also when the depth trigger is met would have 00001100 (i.e. decimal 12) in this byte.

Data Format Specification Records (LIS type 64) at Level 3

1. Entry block 13 is not allowed. This implies only one way to represent depth (e.g. as a data channel).
2. Only type 0, subtype 1 data specification block is allowed. All API curve codes may be set to zero.
3. Channels may be represented by an IEEE 4 byte single precision floating point number (representation code = 128). NOTE: this is an extension to LIS format. See Appendix G.

Data Records

1. The maximum number of data record types in a session is 64.
2. WITS Data Records are defined by a type field in the range of 151 to 230.
NOTE: only type 0 is defined as a data record in the LIS standard. The use of types 151 through 230 as data records is an extension to LIS.

Comment Records (LIS type 232)

1. Have a maximum length of 256 bytes when used as WITS Dialogue Command records.

WITS LEVELS

In order to simplify implementation, four levels of WITS are defined, with each level more complex and comprehensive than the preceding one.

Each level of the specification includes features from previous levels.

WITS LEVEL 0

This is also referred to as the "Intra-Rig Transfer" format since it is primarily intended for exchange of data between Service companies at the rigsite. It uses a simple ASCII format with data items identified by their position within Pre-Defined Data Records. This particular method is intended for the transfer of data in an online ("real-time") mode rather than a batch mode, but it may be adapted to a batch transfer method quite simply. The two parties involved in such a transmission must agree on the communications parameters, frequency of transmissions, etc. The receiving party should expect data to be in the form indicated in the pre-defined record (for example, averaged), and should not be expected or required to manipulate the data in any way. However, if agreed on in advance by the two parties, the transmitted data may be essentially "raw" and then averaged by the receiver.

A Level 0 transmission session comprises a series of DATA SETS, where a data set represents a group of related DATA ITEMS. For example, several cementing data items from the same time interval. A data set may be made up of only one item, or it may comprise many items. In fact, successive data sets may contain different numbers of items. A data set begins with a pair of ampersand characters (&&) (HEX 26) followed by a carriage return/line feed (HEX 0D,0A). A data set is terminated by a pair of exclamation marks (!!) (HEX 21) and a carriage return/line feed.

Data items are separated by a carriage return/line feed.

Restrictions to the content of a Data Set are:

1. A Data Set may not contain Data Items from more than one record type.
2. A Data Item may not be repeated within a Data Set.
3. Unless specifically requested, a Data Item with a -9999.0 null value need not be sent, while an Item with a -8888.0 null value (bad sensor reading) should be sent.

Each data item corresponds to a Pre-Defined Record variable. Each item consists of an "IDENTIFIER" portion and a "VALUE" portion.

The **IDENTIFIER** consists of four characters:

Characters 1 & 2 identify the Pre-Defined Record
Characters 3 & 4 identify the Item within that record

e.g. Resistivity 1 M.Depth (DR1M) is item 13 of Pre-Defined
Record 8 (MWD - Formation Evaluation)

IDENTIFIER = 0813

The **VALUE** portion of the data item may be either a text string, or an ASCII representation of a number.

If it is a text string, it must be no longer than that specified in the Pre-Defined Record. It may be shorter, however. It may contain spaces, special characters, etc., but not && or !.

If numerical, it may be up to 16 characters long, but with at least one number. If present, a negative sign must be the first character. There should be no leading spaces or zeros. A decimal point, if present may fall anywhere before the terminating carriage return/linefeed.

Examples:

Contractor GREEN DRILLING

IDENTIFIER 1981

VALUE GREEN DRILLING

DATA ITEM 1981GREEN DRILLING <CR> <LF>

Resistivity 1 M.Depth 3561.35 feet

IDENTIFIER 0813

VALUE 3561.35

DATA ITEM 08133561.35 <CR> <LF>

Example Transmission Session

The following example transmission session consists of DATA SETS containing four DATA ITEMS (Resistivity 1 M.Depth, Resistivity 1 reading, Gamma Ray 1 M.Depth, Gamma Ray 1 reading) :

```
&&<CR><LF>
08133561.35<CR><LF>
0815.97<CR><LF>          DATA SET 1
08213565.13<CR><LF>
082397.1<CR><LF>
!!<CR><LF>
-----
&&<CR><LF>
08133561.61<CR><LF>
08151.02<CR><LF>          DATA SET 2
08213565.39<CR><LF>
0823100.4<CR><LF>
!!<CR><LF>
-----
etc.
```

WITS Level 1

At this level, binary transmission is used to provide a more efficient means of transfer for the possibly large amounts of data transmitted from the SENDER to the RECEIVER. Transmission is unidirectional.

Only WITS Pre-Defined Data Records are valid at this level (logical record types 151-175). To allow limited customization, this level utilizes "SPARE" channels within the Pre-Defined Data Records. The definition of the additional parameters must be prearranged. Note, however, that Pre-Defined Record 23 contains fields that permit the documentation of up to ten modifications of this type.

Refer to Figure 2.2 for a graphical representation of Level 1 communications.

WITS Level 2

Building onto Level 1, this level introduces the capabilities of bidirectional session dialogue commands which permit the RECEIVER to control, among other things, the record types being transmitted and the interval upon which records are sent. Record content remains limited to Pre-Defined Data Records with "SPARE" customization. Buffering of data records is optional at this level. Where buffering is available, the level designation is 2B rather than 2.

Valid LIS record types at this level are Data Records and Comment Records (logical record type 232).

Refer to Figure 2.3 for a graphical representation of Level 2 communications.

WITS Level 3

At this level, in addition to WITS Pre-Defined Data Records and the capability of session dialogue commands, custom data records may be defined within the scope of WITS-compliant LIS and employing data items from the WITS Data Dictionary or agreed upon in advance by the two parties. The RECEIVER should be able to process Data Format Specification Records and read the subsequent Data Records accordingly. Customized records can be of type 50 through 80 (LIS logical record type 200 through 230) only. Thus, this level allows for a very flexible, though potentially complex, transmission capability. Buffering of data records is mandatory at this level.

Valid LIS record types at this level are Data Records, Comment Records, and Data Format Specification Records.

Refer to Figure 2.4 for a graphical representation of Level 3 communications.

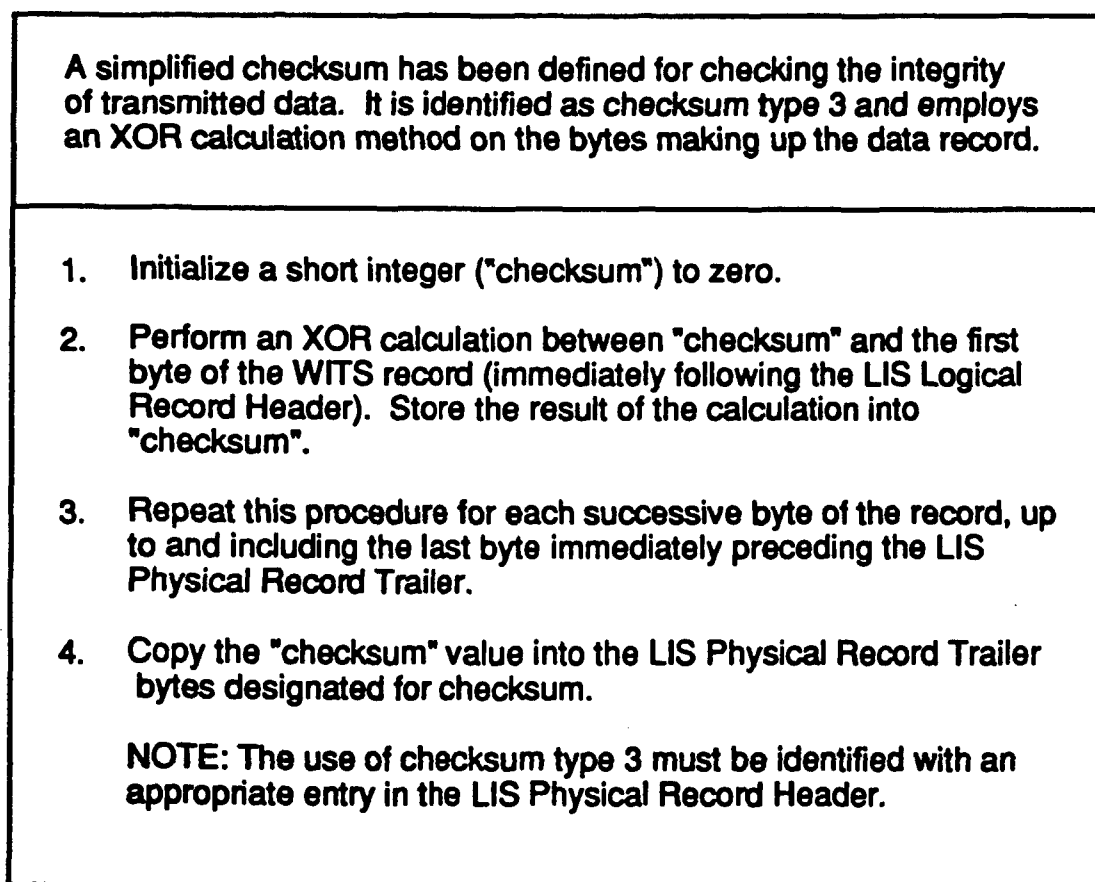


Figure 2.1 Calculation of WITS Special Checksum (Type 3)

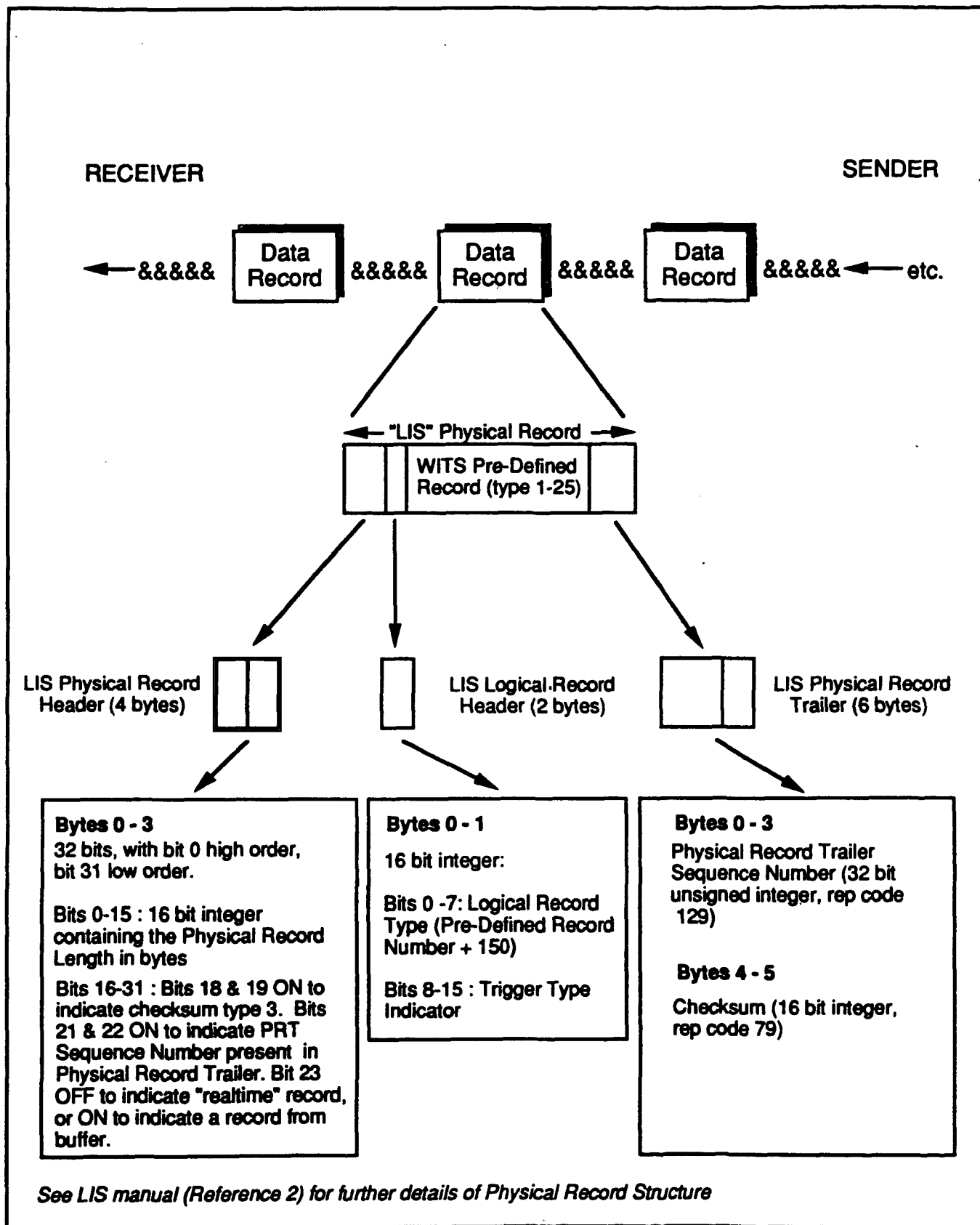
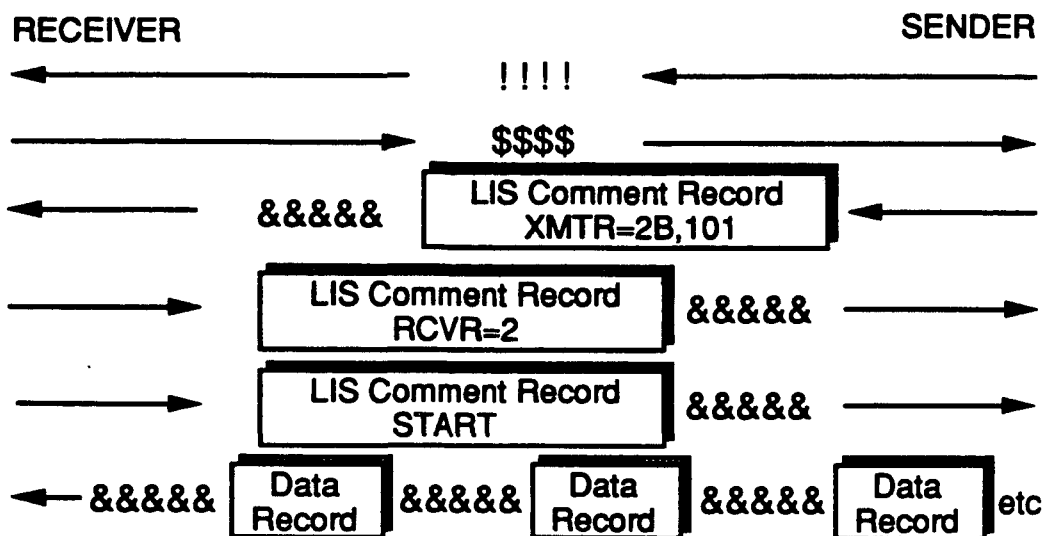


Figure 2.2 WITS format level 1

SENDER INITIATED



RECEIVER INITIATED

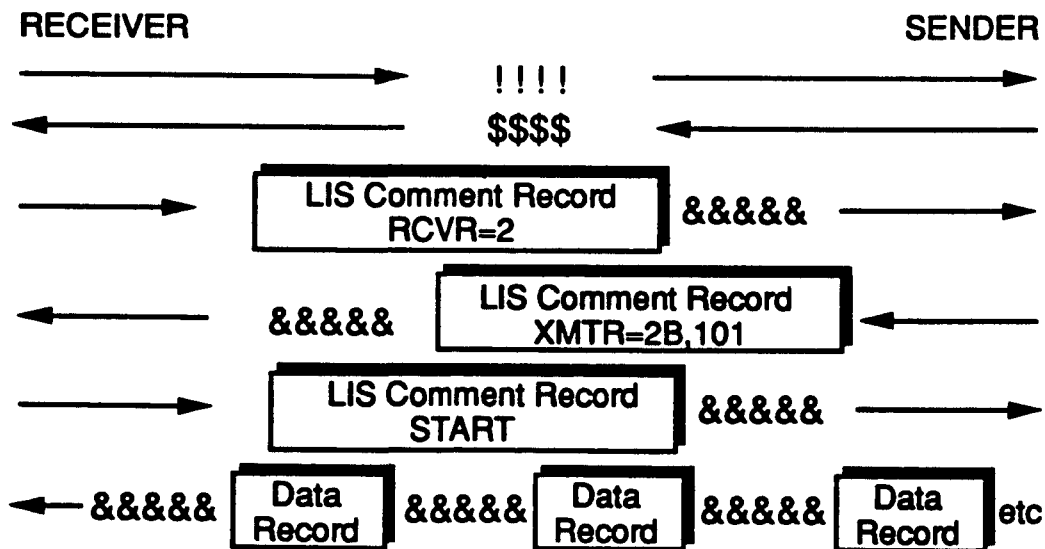


Figure 2.3 WITS format level 2

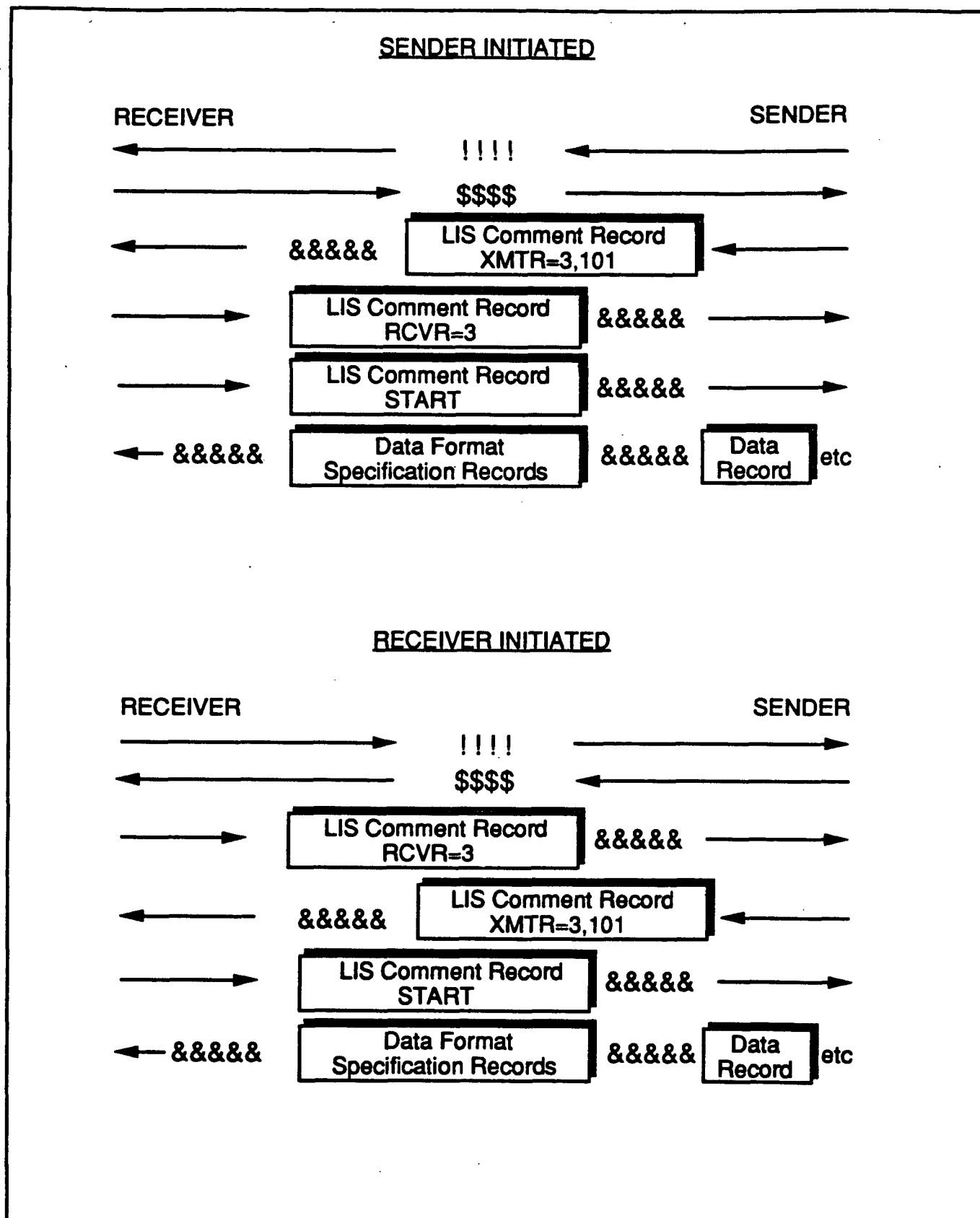


Figure 2.4 WITS format level 3

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SECTION 3: DATA CONTENT

Introduction

This section defines the content of the WITS Data Records which are transmitted within the format specified in Section 2. The concepts of the Data Dictionary for wellsite variables and of Pre-Defined Data Records are discussed.

Data Dictionary

The Data Dictionary consists of an inventory of the majority of wellsite data variables currently being monitored and collected.

For each variable, two unique mnemonics have been assigned. One, the "short" mnemonic, uses a maximum of four characters for compatibility with LIS, while the second, the "long" mnemonic, expands to a maximum of eight characters for use in other applications. The short mnemonics are used in LIS Data Format Specification Records at Level 3 to define the corresponding data record content.

The Data Dictionary of items and their mnemonics, found in Appendix C, serves as the basis for the data item entries in the Pre-Defined Data Records (Appendix A) , and for the construction of customized records. Appendix B is a glossary containing short descriptions of each data item appearing in WITS Pre-Defined Data Records.

Record Definition

The framework for the general structure of all WITS records is as follows:

1. Each record consists of a fixed HEADER, a main BODY, and a limited number of customizable SPARES.
2. The HEADER data items remain fixed from record to record, while the BODY contains the specific data items pertaining to each particular Record Type.
3. The use of SPARE fields permits a small amount of flexibility to customize the record with operator-selected data items.

WITS Record Header

The fixed WITS Record HEADER (not to be confused with the LIS Physical Record Header or Logical Record Header) contains the following entries:

Well Identification
Sidetrack/Hole Section Number
Record Identifier
Sequence Number
Date
Time
Activity Code

The Well Identification consists of sixteen alphanumeric characters. The first 12 characters identify the well/location from which the data is derived. The last four characters identify the source of the data at that well/location (particularly important in situations where more than one SENDER is transmitting data from the same location). This ASCII-formatted number has a valid range from 0000 through 9999. The Operating company supplies the well identifier and source number to each vendor at the start of the service.

An example Well Identification field might be:

WELL#12 0052

where WELL#12 identifies the location and 0052 identifies the source.

The Sidetrack/Hole Section Number further defines the source of the data. It will initially be zero and increment for each sidetrack on the well.

The Record Identifier contains the numerical code for the record type. This will be 1 through 25 for current Pre-Defined Data Records, and 50 through 80 for custom records. Types 26 through 49 are reserved for new Pre-Defined Data Records.

The Sequence Number identifies the sequential position of that particular record type within the data stream, with respect to other records of the same type. Thus the sequence number of each record type keeps count of the number of records within that type that have been generated. For a particular well, this number continues to increment even after a communications break.

Date and Time serve as key fields to help identify the record. Universal Coordinated Time (UCT), also known as Greenwich Mean Time (GMT), is the standard used for date and time values and a conversion from or to local time may be needed, depending on the location of the rig.

The Activity Code is a numerical code identifying the wellsite operation in progress at the time that the record is generated. Appendix E lists defined WITS Activity Codes.

WITS Spares

Following the main body of the record, a limited number of entries are designated SPARES. These contain a null value (-9999.0) if no modification has been made to the record. However, each SPARE entry may be replaced by another item definition. In this way, if only one or two extra variables are required, they may be added to an existing record, rather than having to create a new record. The replacement data item must be able to use the floating point representation code designated for spares.

WITS Pre-Defined Data Records

A group of Pre-Defined Records has been specified. These records have been established using two criteria:

- (1) the rig activity
- (2) the frequency of generation and/or required interval for monitoring of the items. All common rig activities are addressed and the variables applicable to each activity grouped together.

Using these guidelines, a total of 25 records have been defined:

RECORD	RECORD DESCRIPTION
1	General : Time-Based
2	Drilling : Depth-Based
3	Drilling : Connections
4	Hydraulics
5	Tripping : Time-Based
6	Tripping : Connections
7	Survey / Directional
8	MWD Formation Evaluation
9	MWD Mechanical
10	Pressure Evaluation
11	Mud Tank Volumes
12	Chromatograph Gases : Cycle-Based
13	Chromatograph Gases : Depth-Based
14	Lagged Continuous Mud Properties
15	Cuttings / Lithology
16	Hydrocarbon Show
17	Cementing
18	Drill Stem Testing
19	Configuration
20	Mud Report
21	Bit Report
22	Remarks
23	Well Identification
24	Vessel Motion / Mooring Status
25	Weather / Sea State

Pre-Defined Data Record Descriptions

Record 1. General : Time-Based Record : serves as the basic record generated from the wellsite, regardless of rig activity. As such, it is the most general as far as data content is concerned, though heavily weighted towards sensor data rather than computed data. The frequency of generation might range from a few seconds to several minutes, depending on the degree of detail required by the operator.

Record 2. Drilling : Depth-Based Record: generated based on a change in the total depth of the well. The frequency of generation might typically be one record for each foot (meter) of new hole drilled.

Record 3. Drilling : Connection Record: used to record information pertaining to connections made while drilling, i.e. the addition of new drillpipe to the string. Data content includes maximum hookload, average and maximum pulling and running speeds, and duration of the connection. Frequency of generation would be one record per connection.

Record 4. Hydraulics Record: contains predominantly computed hydraulics information, including fluid velocities, circulating system pressure losses etc. Frequency of generation would be on a regular time basis while circulating drilling fluid.

Record 5. Tripping : Time Record: contains information pertaining to the tripping of the drillstring or to the running of a casing/liner string. Included are running/pulling speeds, block position, hookload readings etc. This would serve as a more detailed record of the trip than the connection-based tripping record. Frequency of generation would depend on the degree of detail required but would usually range from a few seconds up to a minute.

Record 6. Tripping : Connection Record: contains summary information pertaining to each connection of a trip or casing run. Included in the record are maximum running/pulling speeds, maximum hookload, time to pull and handle the stand, etc. Frequency of generation would be once per connection.

Record 7. Survey/Directional Record: contains directional survey information. The data may be derived from one of a number of sources including single-shot, multishot, and measurement-while-drilling tools. Frequency of generation would be one record per survey measurement.

Record 8. Measurement-While-Drilling : Formation Evaluation Record: contains the depths and values of MWD sensors used in formation evaluation, including gamma ray, formation resistivity and porosity tool data. Frequency of generation would be on a regular time basis, such as once per minute, or depth basis, such as once per foot (meter).

Record 9. Measurement-While-Drilling : Mechanical Record: contains mechanical parameters measured by MWD tools, including downhole weight-on-bit and downhole torque. Frequency of generation would be on a regular time basis, such as once per minute, or depth basis, such as once per foot (meter).

Record 10. Pressure Evaluation Record: contains predominantly manually entered or computed information relating to formation pressure evaluation performed at the wellsite, including pore pressure, fracture pressure, kick tolerance and overburden pressure. Frequency of generation is on an event basis as new data becomes available for transmission.

Record 11. Mud Tank Volumes Record: permits detailed monitoring and recording of the drilling fluid tank system. Frequency of generation would be on a regular time basis, determined by the degree of detail required.

Record 12. Chromatograph : Cycle Record: contains the results of chromatographic separation of the gas drawn from the returning mud stream. Frequency of generation would be one record per cycle of the chromatograph.

Record 13. Chromatograph : Depth Record: serves as a depth-based summary of chromatographic analysis, featuring average and maximum readings for individual gas constituents over the course of the depth interval. Frequency of generation would be at regular intervals, such as each 10 feet (3 meters), based on a change in the chromatograph sample depth.

Record 14. Lagged Continuous Mud Properties Record: contains the sensor-derived properties of the drilling fluid. Included are such items as density, temperature, conductivity and gas. To permit comparison of "in" and "out" properties of the drilling fluid, the "lagged in" values are also recorded in the record, along with the corresponding "lagged out" values. The record is generated automatically with an incremental change in depth of returns. When all samples have been circulated out of the hole (no further increase in returns depth), the record should be triggered on a time basis.

Record 15. Cuttings/Lithology Record: contains details of the microscopic examination of cuttings derived from the wellbore, including lithology type and description, as well as test results from the cuttings such as bulk density and calcimetry. The record is generated manually for each sample examined, determined by the sampling requirements for the well.

Record 16. Hydrocarbon Show Record: serves as an "addendum" to the Cuttings/Lithology record and is generated when a hydrocarbon "show" is indicated. Record content includes items such as fluorescence, solvent cut, oil stain etc. The record is generated manually after show information has been entered.

Record 17. Cementing Record: contains data relating to cementing activity at the wellsite, including pressures, flow rates, volumes pumped etc. It is generated on a time basis, with the interval determined by the degree of detail required.

Record 18. Drill Stem Testing Record: contains data relating to well testing activity and is generated on a time basis consistent with the degree of detail required.

Record 19. Configuration Record: contains details of the drillstring geometry, wellbore geometry, pump specifications, vendor identification, etc. This record is used to provide the data base with a description of the "environment" in which other data have been collected. A new record is generated following a change to one or more data items in the record. If a number of related changes are being made, the record should be triggered when all changes have been made.

Record 20. Mud Report Record: contains information normally measured and recorded at the wellsite on the Drilling Fluid Report. The record would be generated manually following entry of a new report.

Record 21. Bit Report Record: contains information pertaining to the drilling bit, including type, manufacturer, size, jets, etc. Frequency of generation would be once per trip in or trip out of a bit, i.e. two records per bit. The record would be generated manually following entry of a new report.

Record 22. Remarks Record: permits descriptive information to be included within the data stream and may be manually generated at any time. This might include short remarks concerning hole problems, rig problems, etc.

Record 23. Well Identification Record: contains information such as operator, well name, well location, elevations, etc. In addition, "custom field identifiers" indicate where customization of "spare" fields in Pre-Defined Data Records has been made. The record would normally be manually generated at the beginning of data transfer and again only when changes to one or more fields have been made.

Record 24. Vessel Motion/Mooring Status Record: for use with floating rigs and generated at time intervals determined by prevalent weather conditions and the degree of detail required by the Operator.

Record 25. Weather/Sea State Record: provides environmental information to the Operator. The frequency of generation would be on a time basis, determined by prevalent weather conditions and the degree of detail required by the Operator.

Standard "NULL" value usage

Null values are used within the records in the place of missing numerical or string data.

- When a sensor fails or when any condition causes an invalid data value in a field, that field must contain -8888 for items with representation code 73(L) or 79(S), or -8888.0 for items with representation code 128(F).
- If a data item is simply not available or is unrequested, it should contain -9999 for items with representation codes 73(L) or 79(S), or -9999.0 for items with representation code 128(F).
- Fields defined as text fields, code 65(A), would contain a blank string (HEX 20) or "<NOT AVAILABLE>" message.

Documentation of the Pre-Defined Records

For WITS Level 3, Data Format Specification (DFS) Records are used to provide a definition of subsequent data records. They are required, even for Pre-Defined Data Records, at this level. The Pre-Defined Data Record documentation (Appendix A) has been established to facilitate a simple implementation into LIS DFS records. Each parameter block within the DFS describes an Item of the Pre-Defined Data Record. A DFS parameter block consists of the following:

Data Item Mnemonic
Service ID
Service Order No.
Units Mnemonic
API Codes
File Number
Size
0
Number of samples
Representation Code
Process Indicators

The following entries are defined for each item in the Pre-Defined Data Records:

Data Item Mnemonic	-	from the Data Dictionary
Units Mnemonic	-	from the Data Dictionary
Representation Code	-	the binary format of the data
Size	-	the number of bytes taken up by the data, determined by the representation code in the case of numerical data.

With the exception of Service ID (see below), the other DFS parameter block entries are not used within WITS.

In the case of UNITS definition, two alternatives are supplied. The first set of units is metric; the second is FPS (otherwise commonly referred to as Imperial or English units). For a particular well, the set of units to be used should be agreed upon in advance, and no switching between sets can occur thereafter.

Service ID

As a further definition of a particular item, the Service ID entry of the DFS parameter block has been adopted as a means of identifying the source of certain data items. For example, if the data item is Fluid Density, the Service ID might contain one of the following:

BAL	-	mud balance measurement
DP	-	differential pressure measurement
NUCL	-	nuclear measurement
BUOY	-	buoyancy measurement

This may prove useful in later analysis where the degree of accuracy of the data may be in question. Similarly, the Service ID might also be used to identify the method used for calculated data.

There are no defined mnemonics for use in this case and it would be up to the Service company to provide a list of mnemonics used to the Operator.

Guidelines for further Record and Item definitions

In order to maintain a degree of consistency in the creation of new data item mnemonics, the following guidelines should be followed:

1. Where a new item naturally falls within a group of existing items, the mnemonic should follow the general form of the group. For example, bit data item mnemonics generally have B as a prefix, mud report data item mnemonics generally have MR as a prefix, etc.
2. Where a variable may have several variations, such as minimum, maximum, average, etc., the following convention should be followed: the mnemonic should have a common root, with a suffix indicating the type of reading as follows:

I - instantaneous

N - minimum

X - maximum

A - average

C - cumulative

For example: for hookload readings, the standard four character mnemonics are: HKLI, HKLN, HKLX, HKLA.

3. The eight character mnemonic should be similar to the four character mnemonic as much as possible, using the extra characters for easier interpretation of the variable.
4. Customized data records must follow the general structure of the Pre-Defined Data Records.
5. The key entry of a record, other than date and time which appear in the Header, should be the first entry of the Main Body of the record, i.e. entry 8.

Suggested additions to the WITS Data Dictionary should be forwarded to the WITS subcommittee via the API Petroleum Information Data Exchange for consideration.

Refer to Appendices A, B, C, D, and E for details of the Pre-Defined Data Records, Data Items, Data Dictionary mnemonics, Units mnemonics, and Rig Activity Codes.

SECTION 4 : SESSION DIALOGUE

Introduction

WITS Session Dialogue is used for the online bidirectional transfer of special commands which determine the ongoing activity during the communication session. Session dialogue is only available at WITS Level 2 and above. WITS Levels 0 and 1 are unidirectional only and do not support these commands.

LIS is used predominantly for transfer of data in a batch (tape) environment and does not support bidirectional data transfer or control by the receiving party over the datastream content or transfer rate. WITS introduces a number of Session Dialogue Commands which are used for controlling the data transfer process.

Session Dialogue Commands are transmitted in LIS Comment records (type 232). Only printable ASCII characters are utilized within a command. Note, however, that since Commands are encapsulated within an LIS record, the LIS logical and physical record headers and trailers will include binary information.

LIS Comment records may occur anywhere between the start and end of a communications session.

LIS Comment records containing Session Dialogue Commands or other messages are the only type of record that a RECEIVER may send and therefore the only type that the SENDER need handle.

Opening the Communications Session

The session is started by the interchange between the SENDER and RECEIVER of a pair of startup strings ("!!!!" and "\$\$\$\$"). This initial sequence is shown in Figures 2.3 and 2.4 as part of the command sequences required for startup at Levels 2 and 3. Either the SENDER or the RECEIVER may initiate the opening of the communications channel and both parties should look for the "!!!!" and the "\$\$\$\$" strings on the communication port during this initial sequence.

Loss of Synchronization and Resynchronization

To facilitate resynchronization during communications line problems each Physical Record must be preceded by "&&&&". The RECEIVER should verify that each record is preceded by "&&&&". To resynchronize, the system should discard bytes until the "&&&&" sequence is received. This resynchronization procedure could fail and may need to be repeated. If unsuccessful after three attempts, a full startup procedure should be initiated. If the RECEIVER detects the loss of synchronization and resynchronization is unsuccessful, the RECEIVER should begin a "Receiver Initiated startup". If the SENDER detects the loss of synchronization and resynchronization is unsuccessful, the SENDER should begin a "Sender Initiated startup".

Closing the Communications Session

Either the SENDER or the RECEIVER may initiate a communications session shutdown by transmitting a Shutdown command. The receipt of this command should force the other party to initiate a startup sequence.

SESSION DIALOGUE COMMAND SYNTAX

Session Dialogue Commands are embedded within LIS Comment Records. The content of a Comment Record may be recognized as being a Command rather than simply a message by the following syntax:

WITS <SOURCE> <TARGET> <COMMAND> [=ARG1[,ARG2,...,ARGn]]

1. All Command records begin with WITS as the first four characters.
2. A space (HEX 20) follows the WITS label.
3. <SOURCE> is a four character identifier for the source location of the command. The SOURCE address is in the form 0001, 0002, 0104, etc., and it is the responsibility of the Operator to assign a unique address to each location. Location 0000 is reserved for the principal RECEIVER on a system.
4. The SOURCE address is followed by a space (HEX 20).
5. <TARGET> is a four character identifier for the target location of the command. The TARGET address is in the form 0001, 0002, 0104, etc., and it is the responsibility of the Operator to assign a unique address to each location. A special case is 9999 which signifies all locations on the system.
6. The TARGET address is followed by a space (HEX 20).
7. <COMMAND> is defined in the Commands section which follows.
8. ARGn is one of the arguments to a Command. Valid arguments for each Command are defined with the Command section which follows.
9. [] Denotes Optional
10. Each Command may contain 0 to 32 arguments.
11. Arguments (if present) are separated from <COMMAND> by an equal sign (=) and from each other by a comma (,). No spaces are allowed within a command and its argument list.
12. Only one Command per Comment Record is permissible.

WITS SESSION DIALOGUE COMMANDS

1. I am a SENDER

Format XMTR=LEVEL[,REC]

LEVEL is the highest WITS format level that the SENDER is capable of providing. Levels currently specified are 2, 2B and 3.

REC is not used at WITS Level 2 but is mandatory at WITS Levels 2B and above. It is the Physical Record Trailer Sequence Number of the last data record generated by the SENDER (i.e. latest one available in the buffer).

Example WITS 0015 0000 XMTR=2B,54356

Tells the RECEIVER (address 0000) that the SENDER (address 0015) can operate at levels up to and including Level 2B and that the most recent data record generated for this well has a PRTSN of 54356.

2. I am a RECEIVER

Format RCVR=LEVEL

LEVEL is the highest WITS format level that the RECEIVER is capable of handling. Levels currently specified are 2, 2B and 3.

Example WITS 0000 0015 RCVR=3

3. Start Transmitting

Format START

Sent by the RECEIVER to indicate it is ready to start receiving DATA records. This allows the RECEIVER to first send dialogue commands for date/time, transmission rates, data intervals, etc., before receiving data records.

Example WITS 0000 0015 START

NOTE: This does not indicate when to start collecting and buffering data records, which might be required in advance of transmission. This merely indicates when the RECEIVER is ready to receive transmitted data records.

4. Orderly Shutdown

Format END

Sent by either the SENDER or RECEIVER to initiate shutdown of communications. The recipient should respond by initiating the normal startup sequence.

Example WITS 0000 9999 END

5. Set Date and Time

Format DATE=YYYYMMDDhhmmss

YYYY = year, MM = month(1-12), DD = day
hh = hours(0-23), mm = minute(0-59), ss = second(0-59)

May be sent by either SENDER or RECEIVER to synchronize date and time. Dates and times are Universal Coordinated Time (Greenwich Mean Time).

Example WITS 0000 9999 DATE=19900716142110

to set the date to July 16, 1990 and the time to 21 minutes and 10 seconds after 2 P.M. at all locations

6. Transmission Rate

Format XRATE=RATE

RATE is the minimum time interval (in seconds) between transmission of successive records.

Sent by the RECEIVER to indicate the highest rate of transmission that it can handle. This value is the ASCII representation of a real number and not necessarily a whole number of seconds. The default value is 1. A rate of 0 means that the SENDER can transmit records as fast as it wishes.

Example WITS 0000 0001 XRATE=.5

The RECEIVER (0000) informs the SENDER (0001) that it does not want to receive records closer together than half a second (based on the start of each record).

7. Specify Data Records to be Updated by Time Interval

Format **RATE=REC:SEC[,REC:SEC[,...REC:SEC]]**

RATE updates are valid for the following Pre-Defined Data Records:

1, 4, 5, 8, 9, 11, 14, 17, 18, 24, 25

REC is the WITS Data Record type number or ALL to set a rate for all valid record types. SEC is the update interval in seconds. Set SEC to 0 to disable data collection and transmission for the specified record type(s). Sent by RECEIVER to change record update intervals from defaults. If ALL is used, it should be the only argument.

Example WITS 0000 0001 RATE=11:300,1:60

to set record type 11 to 5 minute updates and record type 1 to 1 minute updates at SENDER 0001.

WITS 0000 0001 RATE=ALL:0

to shut down all time driven updates from SENDER 0001.

NOTE: See Section 5 for more information concerning data averaging following a transmission interval change

8. Specify Data Records to be updated by Depth Interval

Format **DEPTH=REC:DIST[,REC:DIST[,...REC:DIST]]**

DEPTH updates are valid for the following Pre-Defined Data Records:

2, 8, 9, 13, 14

REC is the WITS Data Record type number or ALL to set a rate for all valid record types. DIST is the update interval in depth units or fractions thereof. Set DIST to 0 to disable data collection and transmission for the specified record type(s). Sent by RECEIVER to change record update intervals. If ALL is used, it should be the only argument.

Example WITS 0000 0011 DEPTH=2:0.5

Sets Record type 2 for update every 1/2 depth units (e.g. 0.5 ft, or 0.5 m) from SENDER 0011.

WITS 0000 0011 DEPTH=ALL:0

to shutdown all depth interval updates from SENDER 0011.

NOTE: See Section 5 for more information concerning data averaging following a transmission interval change

9. Specify Data Records to be updated by Event Trigger.

Format EVENT=REC:FREQ[,REC:FREQ[,...REC:FREQ]]

EVENT updates are valid for the following Pre-Defined Data Records:

3, 6, 7, 10, 12, 15, 16, 19, 20, 21, 22, 23

REC is the WITS Data Record type number or ALL to set a rate for all valid record types.

FREQ is the update frequency of transmission for the record type. Set FREQ to 0 to disable data collection and transmission for the specified record type(s). Under most circumstances, FREQ would only be 0 to disable the record type, or 1 to enable it. If ALL is used, it should be the only argument.

Example WITS 0000 9999 EVENT=7:0,12:1

Turns off Record type 7 and sets Record 12 to transmit at each event (each chromatograph cycle), i.e. turning it on, for all SENDERS on the system.

WITS 0000 9999 EVENT=ALL:1

to turn on all event triggered records for all SENDERS on the system.

10. I'm Alive

Format HI

Sent by either SENDER or RECEIVER to inform the other party that the system is alive. While the interval should be configurable this command should be sent at least once per minute in the absence of other transmitted records or when requested by the "Are You Alive" command. The transmission of other WITS records resets this timer.

Example WITS 0000 0015 HI

11. Are You Alive?

Format HELLO?

Sent to request an acknowledgement that the other party is still connected. This would normally be sent after timing out with no receipt of the "I'm Alive" command or other WITS record. The recipient should immediately respond with an "I'm Alive" command or other WITS record. If, after sending this command, there is no receipt of "I'm Alive" or other WITS record within 15 seconds, the startup sequence should be initiated in an attempt to reconnect with the other party.

Example WITS 0015 0000 HELLO?

12. Poll a data record

Format POLL=REC[,REC[,...REC]]

REC is the WITS Data Record type number or ALL to select all currently active records. Sent by RECEIVER to request one or more data records to be immediately transmitted. If the requested record is currently inactive, the poll will be ignored. If ALL is used, this should be the only argument.

Example WITS 0000 0015 POLL=4,5,6

To request immediate transmission of record types 4,5 and 6 from SENDER 0015.

NOTE: When a record is polled and sent at a time/depth other than at it's currently scheduled interval, any averaged values within the record should represent the average from the time/depth of the last transmitted record of that type to the time/depth of the polled transmission. This should not affect the overall average value for the next scheduled interval. Also, due to the predominantly manually-entered nature of the data if Pre-Defined Data Records 7, 10, 15, 16, 19, 20, 21, 22 and 23, a POLL of these records will generate a record containing the last entered information.

13. Retransmit/Batch Transfer Records

Format REXMIT = <start>:<end>,<records>,<mode>

Sent by the RECEIVER to request the retransmission or batch transfer of a range of data records. This might be used if a checksum error has occurred on an individual record, if the communication line is interrupted resulting in buffered records in the wellsite system, or in the case where batch transfer of collected data is required rather than online transmission.

where: start	=	The first record (Physical Record Trailer Sequence Number) to send, where 0 means stop sending the currently selected range immediately. If this record is not available, start from the first record that is in the buffer.
end	=	The last record (Physical Record Trailer Sequence Number) to send, where 0 means proceed until caught up with the first "realtime" record sent (0 only applicable if mode is "I").
records	=	ALL for all WITS Data Record types, or colon delimited record type numbers, e.g. 1:2:4:15 for records 1,2,4 and 15.
mode	=	"I" to INTERSPERSE "buffered" data with "realtime" records, or "F" (FIRST IN/FIRST OUT or FIFO) to transmit the requested range without interspersing "realtime" records which are added to the end of the buffer. In mode "F", at the end of the specified range, records buffered during that period are transmitted in order until the system catches up to current time.

Example WITS 0000 0001 REXMIT=5434:5434,ALL,I
Retransmit/send record with PRTSN of 5434

Example WITS 0000 0001 REXMIT=5434:5576,ALL,F
Retransmit/send all records in range 5434 to 5576 in FIFO mode

Retransmit/Batch Transfer Records (continued)

Example WITS 0000 0001 REXMIT=0:5576,ALL,I
Retransmit/send from first record in buffer to number 5576, in interspersed mode with "realtime" records

Example WITS 0000 0001 REXMIT=5555:0,1:2,I
Retransmit/send record types 1 and 2 only from 5555 until caught up with "realtime" records, sending in interspersed format

Example WITS 0000 0001 REXMIT=5555:5400,ALL,I
Illegal and ignored since end record less than start but not 0.

Refer to the Section 5 for further details concerning BUFFERING.

14. Message

Format MSG = <message string>

Used to allow two-way messages within the dialogue command structure employing the SENDER/RECEIVER identifiers.

Example WITS 0000 0001 MSG=This is a test message

The RECEIVER (0000) sends a message to the SENDER (0001).

SECTION 5 : DATA HANDLING

Introduction

This section covers some of the particular implementation questions relating to the processing of WITS Pre-Defined Data Records and their contents. It also covers the means by which data are buffered for retransmission or batch transfer.

DATA PROCESSING

Record Validity

Most of the Pre-Defined Data Records have periods during which their data are not valid, such as Hydraulics (Record 4) when not pumping or MWD (Records 8 & 9) when the MWD tool is not transmitting. Transmission of these records should be suppressed by the SENDER until they are once again valid. Detailed information on record validity is contained in Appendix A.

Key Depth/Time Items

The key variable in depth- and time-triggered records should represent the depth/time at the end of the interval.

The transmitted value for the key depth item in depth-triggered records should always be an integral multiple of the depth interval for that record, i.e. $n \cdot 0.25$, $n \cdot 0.50$, $n \cdot 0.75$ or $n + 1.0$ for a 0.25 interval. If the rate of penetration is too high for the SENDER to process a record for every depth interval, then those intervals should be skipped, rather than sending the records at odd depths. If, for some reason, the SENDER must make manual corrections to the depth, some depth intervals may be skipped if the correction was forward, or there may be repeated intervals if the correction was backward. The transmitted value for the time in time-triggered records does not have to be a whole multiple of that record's time interval. It should however be as close as possible to the correct interval from the time of transmission of the previous record of that type.

For polled records, or time-triggered transmissions of records with both time and depth intervals (e.g. Records 8 & 9), the key depth variable should be its current value, not the expected depth interval end value.

Computed Data Items

Most records contain values that require some form of processing over the record interval. This includes average, minimum, maximum and last values. The description of each variable in Appendix B indicates which processing should be applied. If none is specified, last value can be assumed. Each record has valid conditions for which data should be included in this processing (on bottom, out-of-slips, etc.) that is detailed in Appendices A and B. Data that are collected while these conditions are not valid should not be included in the processing for that interval. For some periodic measurements, such as MWD and Chromatograph, it is possible that new values for some or all items in a record will not become available during an averaging period. Any variables for which no new data have been received should be treated as unavailable (-9999). If none of the items in a record have been updated since the record's last transmission, the record should not be sent.

RATE CHANGES

The following describes the handling of record interval changes with respect to record synchronization and averaging. This is particularly applicable to rate change requests contained in Dialogue Commands at WITS Level 2B and above.

a. TIME interval

If the time interval is changed for a record, the next trigger time for that record is set to the time of receipt of the RATE command plus the requested time interval. For example:

Last record sent at : 10:22:00
Current time interval : 30 seconds
Next trigger time for record : 10:22:30

At 10:22:12, receive a time interval for the record of 60 seconds
New trigger time for record : 10:23:12

Any averaged data will be for the interval 10:22:00 through 10:23:12

NOTE: the new trigger time is set, even if the time interval for the record did not change.

b. DEPTH interval

If the depth interval is changed for a record, the next trigger depth for that record is set to the next integral of the new depth interval. For example:

Last record sent at : 5004 ft
Current depth interval : 2 ft
Next trigger depth for record : 5006 ft

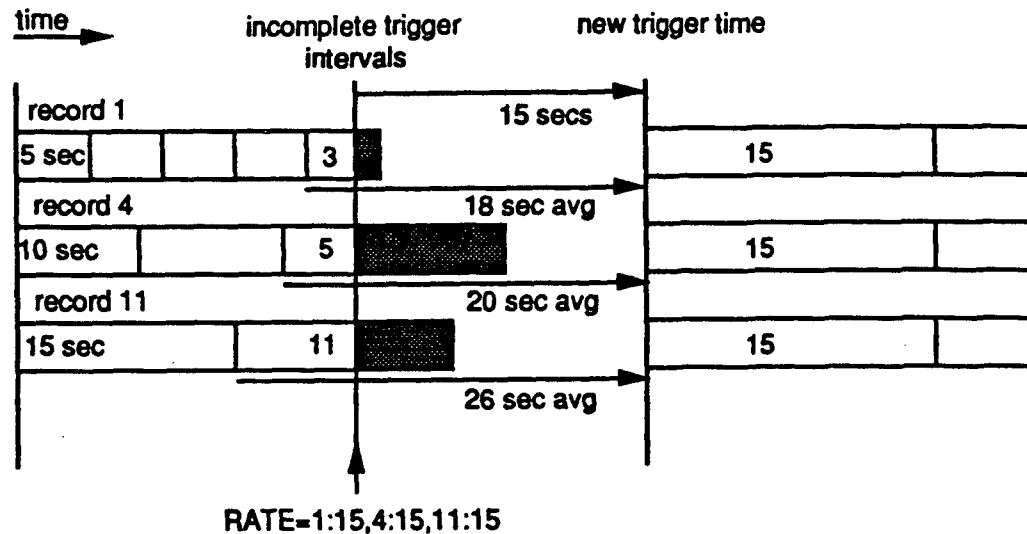
At depth 5005.3 ft, receive a depth interval for the record of 0.5 ft
New trigger depth for record : 5005.5 ft

Any averaged data will be for the interval 5004 ft through 5005.5 ft

Note: the new trigger depth is set, even if the depth interval for the record did not change.

Using these procedures, the RECEIVER may synchronize a number of records by issuing a DEPTH or RATE command containing the required records.

For example:



As can be seen, the first records received following the synchronization will usually have data averaged over irregular intervals. Following that, the records should arrive at about the same time and contain data measured over the same interval.

BUFFERING

WITS buffering and retransmission is employed at WITS Level 2 (optional) and Level 3.

This should not be confused with database archiving. The WITS buffer is simply a duplicate copy of the record as it was (or would have been) transmitted, including the Physical Record Header and Trailer. This buffer is used as a means of storage for later catch up during communications line loss, as a means by which the RECEIVER can request retransmissions of single records or a range of records (for example, if a checksum error was detected on a received record), and in cases where only batch transmission of collected data is required (no online transmission).

Every record has a unique identifier stored in its Physical Record Trailer. This is termed the Physical Record Trailer Sequence Number (PRTSN). This is the number which the RECEIVER refers to when requesting retransmissions. It starts at 1 (one) for the first record in the well and increments throughout the well, including during and after communications line loss.

A bit in the Physical Record Header (bit 23) indicates whether the record is a "realtime" record or whether it has been transmitted from the buffer. Thus, if the record is transmitted at its proper triggering time, the bit is 0 (clear). A duplicate copy of the record should be recorded to the buffer with the bit set to 1. Any time that the record is pulled from the buffer for retransmission, the set bit will indicate that it comes from the buffer.

No specific size of buffer is mandated, though it is recommended that a minimum of 10 megabytes of storage is allotted in the form a "circular" buffer which should be capable of holding at least the last 24 hours of data records. Of course, the larger the buffer the better since this allows access to more historic data for retransmission.

Storage to the buffer is automatic. Retrieval from the buffer for retransmission is under RECEIVER control. The REXMIT Dialogue Command is sent by the RECEIVER to give the range of records to be transmitted (identified by the PRTSN), the types of records within that range, and the mode of transmission.

Only records which are ACTIVE (i.e. which have a triggering interval) are stored into the buffer. It is the responsibility of the RECEIVER to ensure that the required records are ACTIVE. If, during a break in communications, a change to the active state or the triggering interval of records is required, the RECEIVER should convey this information to the SENDER by means of another communications medium. Alternatively, the RECEIVER and SENDER should have a prior agreement on the procedure to be followed during communications line loss, particularly in the area of record activity and buffering intervals. The latter may be especially relevant if the line is down for an extensive period.

On resumption of transmission, a REXMIT command specifying ALL records will include all records buffered through the specified PRTSN range, regardless of the current record activity. That is, if a data record was active, and therefore buffered, during an interruption of communications and the record was then made inactive by the RECEIVER prior to issuing a REXMIT command, it will still be transmitted. If this is not the desired action, the RECEIVER should explicitly specify required records in REXMIT rather than use the ALL argument.

The mode of transmission may be "I" for interspersed or "F" for FIFO. Interspersed means that the retransmitted records are to be sent interspersed with "realtime" records (with priority given to the latter). FIFO (first in, first out) means that the range specified should be transmitted immediately and in a non-interspersed form. Records generated while this retransmit is in progress are added to the end of the buffer. A pointer to this data should be kept to allow the SENDER, after transmitting the requested range, to catch up to "realtime".

Following communications line loss, the RECEIVER has knowledge of the last Data Record received (from its PRTSN). On the restart, the SENDER includes its current Data Record number in the XMTR command. The RECEIVER can then make the decision whether immediate retransmission is required and, if so, whether to request the buffered records to be interspersed with "realtime" records or to send them in FIFO mode. The RECEIVER would then normally issue the REXMIT command with the necessary arguments prior to the START command which starts the Data Record transmission.

APPENDIX A : WITS PRE-DEFINED DATA RECORDS

This appendix contains details of the 25 current WITS Pre-Defined Data Records. The content and format of these records has been fixed for use in levels 1 and 2 of WITS although there is no reason that they should not be used at higher levels.

NOTES

The following representation codes are used in the Pre-Defined Records:

Identifier	Rep Code	Description
A	65	Alphanumeric
S	79	16 bit 2's complement signed integer
L	73	32 bit 2's complement signed integer
U	129	32 bit 2's complement unsigned integer
F	128	32 bit IEEE single precision floating point

Examples of the format of representation codes 65, 73 and 79 may be found in the LIS handbook (Reference 2). Code 129 is an extension of LIS. It uses the same byte order as code 73 but is unsigned. Code 128 is also an extension of LIS to enable the use of the more widely accepted IEEE format. See Appendix G for more information on the format of this representation code.

For each data item, a long mnemonic and a short mnemonic are given. It should be noted that only the short mnemonic may be used in Data Format Specification records while either may be used in other circumstances.

The transmission intervals for Pre-Defined records are specified by the Operator prior to the start of service. At levels 2 and above, these transmission intervals may be changed by the RECEIVER through the use of Session Dialogue Commands (See Section 4).

RECORD # 1 : GENERAL TIME-BASED

Logical Record Type: 151

WITS Record ID : 1

Auto/Manual: AUTOMATIC

Trigger : [TIME] Transmit at a specified time interval (secs)

Data Source : Data acquired in real-time and computed over the trigger interval; record transmitted and computation reset when triggering interval occurs.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	—	—
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	—	—
3	Record Identifier	RECID	RID	S	2	—	—
4	Sequence Identifier	SEQID	SQID	L	4	—	—
5	Date	DATE	DATE	L	4	—	—
6	Time	TIME	TIME	L	4	—	—
7	Activity Code	ACTCOD	ACTC	S	2	—	—
8	Depth Bit (meas)	DEPTBITM	DBTM	F	4	M	F
9	Depth Bit (vert)	DEPTBITV	DBTV	F	4	M	F
10	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
11	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
12	Block Position	BLKPOS	BPOS	F	4	M	F
13	Rate of Penetration (avg)	ROPA	ROPA	F	4	M/HR	F/HR
14	Hookload (avg)	HKLA	HKLA	F	4	KDN	KLB
15	Hookload (max)	HKLX	HKLX	F	4	KDN	KLB
16	Weight-on-Bit (surf,avg)	WOBA	WOBA	F	4	KDN	KLB
17	Weight-on-Bit (surf,max)	WOBX	WOBX	F	4	KDN	KLB
18	Rotary Torque (surf,avg)	TORQA	TQA	F	4	KNM	KFLB
19	Rotary Torque (surf,max)	TORQX	TQX	F	4	KNM	KFLB
20	Rotary Speed (surf,avg)	RPMA	RPMA	S	2	RPM	RPM
21	Standpipe Pressure (avg)	SPPA	SPPA	F	4	KPA	PSI
22	Casing (Choke) Pressure	CHKP	CHKP	F	4	KPA	PSI
23	Pump Stroke Rate #1	SPM1	SPM1	S	2	SPM	SPM
24	Pump Stroke Rate #2	SPM2	SPM2	S	2	SPM	SPM
25	Pump Stroke Rate #3	SPM3	SPM3	S	2	SPM	SPM
26	Tank Volume (active)	TVOLACT	TVA	F	4	M3	BBL
27	Tank Volume Change (act)	TVOLCACT	TVCA	F	4	M3	BBL
28	Mud Flow Out %	MFOP	MFOP	S	2	%	%
29	Mud Flow Out (avg)	MFOA	MFOA	F	4	L/M	GPM
30	Mud Flow In (avg)	MFIA	MFIA	F	4	L/M	GPM
31	Mud Density Out (avg)	MDOA	MDOA	F	4	KGM3	PPG
32	Mud Density In (avg)	MDIA	MDIA	F	4	KGM3	PPG
33	Mud Temperature Out (avg)	MTOA	MTOA	F	4	DEGC	DEGF
34	Mud Temperature In (avg)	MTIA	MTIA	F	4	DEGC	DEGF
35	Mud Conductivity Out (avg)	MCOA	MCOA	F	4	MMHO	MMHO
36	Mud Conductivity In (avg)	MCIA	MCIA	F	4	MMHO	MMHO
37	Pump Stroke Count (cum)	STKC	STKC	L	4	—	—
38	Lag Strokes	LAGSTKS	LSTK	S	2	—	—
39	Depth Returns (meas)	DEPTRETM	DRTM	F	4	M	F
40	Gas (avg)	GASA	GASA	F	4	%	%
41	< SPARE 1 >	SPARE1	SPR1	F	4	—	—
42	< SPARE 2 >	SPARE2	SPR2	F	4	—	—
43	< SPARE 3 >	SPARE3	SPR3	F	4	—	—
44	< SPARE 4 >	SPARE4	SPR4	F	4	—	—
45	< SPARE 5 >	SPARE5	SPR5	F	4	—	—

RECORD # 2 : DRILLING DEPTH-BASED

Logical Record Type : 152

WITS Record ID : 2

Auto/Manual: AUTOMATIC

Trigger : [DEPTH] Transmit at a specified depth interval (feet or meters)

Data Source : Data acquired in real-time when on-bottom drilling NEW hole and computed over the trigger interval.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	---	---
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	---	---
3	Record Identifier	RECID	RID	S	2	---	---
4	Sequence Identifier	SEQID	SQID	L	4	---	---
5	Date	DATE	DATE	L	4	---	---
6	Time	TIME	TIME	L	4	---	---
7	Activity Code	ACTCOD	ACTC	S	2	---	---
8	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
9	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
10	Rate of Penetration (avg)	ROPA	ROPA	F	4	M/HR	F/HR
11	Weight-on-Bit (surf,avg)	WOBA	WOBA	F	4	KDN	KLB
12	Hookload (avg)	HKLA	HKLA	F	4	KDN	KLB
13	Standpipe Pressure (avg)	SPPA	SPPA	F	4	KPA	PSI
14	Rotary Torque (surf,avg)	TORQA	TQA	F	4	KNM	KFLB
15	Rotary Speed (surf,avg)	RPMA	RPMA	S	2	RPM	RPM
16	Bit Revolutions (cum)	BTREVC	BRVC	L	4	---	---
17	Mud Density In (avg)	MDIA	MDIA	F	4	KGM3	PPG
18	ECD at Total Depth	ECDTD	ECDT	F	4	KGM3	PPG
19	Mud Flow In (avg)	MFIA	MFIA	F	4	L/M	GPM
20	Mud Flow Out (avg)	MFOA	MFOA	F	4	L/M	GPM
21	Mud Flow Out %	MFOP	MFOP	S	2	%	%
22	Tank Volume (active)	TVOLACT	TVA	F	4	M3	BBL
23	Cost/Distance (inst)	CPDI	CPDI	F	4	\$/M	\$/F
24	Cost/Distance (cum)	CPDC	CPDC	F	4	\$/M	\$/F
25	Bit Drilled Time	BTDTIME	BDTI	F	4	HR	HR
26	Bit Drilled Distance	BTDDIST	BDDI	F	4	M	F
27	Corr. Drilling Exponent	DXC	DXC	F	4	---	---
28	< SPARE 1 >	SPARE1	SPR1	F	4	---	---
29	< SPARE 2 >	SPARE2	SPR2	F	4	---	---
30	< SPARE 3 >	SPARE3	SPR3	F	4	---	---
31	< SPARE 4 >	SPARE4	SPR4	F	4	---	---
32	< SPARE 5 >	SPARE5	SPR5	F	4	---	---
33	< SPARE 6 >	SPARE6	SPR6	F	4	---	---
34	< SPARE 7 >	SPARE7	SPR7	F	4	---	---
35	< SPARE 8 >	SPARE8	SPR8	F	4	---	---
36	< SPARE 9 >	SPARE9	SPR9	F	4	---	---

RECORD # 3 : DRILLING CONNECTIONS

Logical Record Type : 153

WITS Record ID : 3

Auto/Manual: AUTOMATIC

Trigger : [EVENT] Transmit when first back on bottom following a drilling connection

Data Source : Data acquired from first off-bottom to back on-bottom.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	—	—
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	—	—
3	Record Identifier	RECID	RID	S	2	—	—
4	Sequence Identifier	SEQID	SQID	L	4	—	—
5	Date	DATE	DATE	L	4	—	—
6	Time	TIME	TIME	L	4	—	—
7	Activity Code	ACTCOD	ACTC	S	2	—	—
8	Depth Connection (meas)	DEPTCONM	DCNM	F	4	M	F
9	Depth Connection (vert)	DEPTCONV	DCNV	F	4	M	F
10	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
11	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
12	Elapsed Time Bottom-Slips	ETIMEBTS	ETBS	S	2	SEC	SEC
13	Elapsed Time In-Slips	ETIMESLP	ETSL	S	2	SEC	SEC
14	Elapsed Time Slips-Bottom	ETIMESTB	ETSB	S	2	SEC	SEC
15	Elapsed Time Pumps-Off	ETIMEPOF	ETPO	S	2	SEC	SEC
16	Running Speed - up (max)	RSUX	RSUX	F	4	M/S	FPM
17	Running Speed - down (max)	RSDX	RSDX	F	4	M/S	FPM
18	Hookload (max)	HKLX	HKLX	F	4	KDN	KLB
19	String Weight (rot,avg)	STRGWT	STWT	F	4	KDN	KLB
20	Torque - Make Up (max)	TORQMUX	TQMX	F	4	KNM	KFLB
21	Torque - Breakout (max)	TORQBOX	TQBX	F	4	KNM	KFLB
22	< SPARE 1 >	SPARE1	SPR1	F	4	—	—
23	< SPARE 2 >	SPARE2	SPR2	F	4	—	—
24	< SPARE 3 >	SPARE3	SPR3	F	4	—	—
25	< SPARE 4 >	SPARE4	SPR4	F	4	—	—
26	< SPARE 5 >	SPARE5	SPR5	F	4	—	—

RECORD # 4 : HYDRAULICS

Logical Record Type : 154

WITS Record ID : 4

Auto/Manual: AUTOMATIC

Trigger : [TIME] Transmit at a specified time interval (secs)

Data Source : Data acquired in real-time while circulating drilling fluid. Not sent if no circulation is taking place. Minimum and maximum values reset when record is transmitted. Other items should reflect the input and output variables used in the most recent hydraulics calculation prior to transmission.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	---	---
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	---	---
3	Record Identifier	RECID	RID	S	2	---	---
4	Sequence Identifier	SEQID	SQID	L	4	---	---
5	Date	DATE	DATE	L	4	---	---
6	Time	TIME	TIME	L	4	---	---
7	Activity Code	ACTCOD	ACTC	S	2	---	---
8	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
9	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
10	Depth Bit (meas)	DEPTBITM	DBTM	F	4	M	F
11	Depth Bit (vert)	DEPTBITV	DBTV	F	4	M	F
12	Mud Density In (avg)	MDIA	MDIA	F	4	KGM3	PPG
13	Mud Flow In (avg)	MFIA	MFIA	F	4	L/M	GPM
14	Standpipe Pressure (avg)	SPPA	SPPA	F	4	KPA	PSI
15	Plastic Viscosity	PV	PV	F	4	CP	CP
16	Yield Point	YP	YP	F	4	PA	PHSF
17	Pressure Loss - bit	PLB	PLB	F	4	KPA	PSI
18	Pressure Loss - string	PLDS	PLDS	F	4	KPA	PSI
19	Pressure Loss - annulus	PLA	PLA	F	4	KPA	PSI
20	Pressure Loss - surface	PLSU	PLSU	F	4	KPA	PSI
21	Pressure Loss - mud motor	PLMM	PLMM	F	4	KPA	PSI
22	Pressure Loss - MWD tool	PLMWD	PLMW	F	4	KPA	PSI
23	Pressure Loss - % at bit	PLPB	PLPB	F	4	%	%
24	Bit Hydraulic Power	BHP	BHP	F	4	KW	HP
25	Bit Hydraulic Power/Area	BHPA	BHPA	F	4	KWM2	HSI
26	Jet Impact Force	JIF	JIF	F	4	KDN	LB
27	Jet Velocity	JV	JV	F	4	M/S	FPS
28	Annular Velocity (min)	AVELN	AVN	F	4	M/S	FPM
29	Annular Velocity (max)	AVELX	AVX	F	4	M/S	FPM
30	ECD at Total Depth	ECDTD	ECOT	F	4	KGM3	PPG
31	ECD at Bit	ECDBIT	ECDB	F	4	KGM3	PPG
32	ECD at Casing Shoe	ECDCSG	ECDC	F	4	KGM3	PPG
33	Pump Hydraulic Power	PHP	PHP	F	4	KW	HP
34	Calc/Obs Press.Loss ratio	PLCO	PLCO	F	4	%	%
35	< SPARE 1 >	SPARE1	SPR1	F	4	---	---
36	< SPARE 2 >	SPARE2	SPR2	F	4	---	---
37	< SPARE 3 >	SPARE3	SPR3	F	4	---	---
38	< SPARE 4 >	SPARE4	SPR4	F	4	---	---
39	< SPARE 5 >	SPARE5	SPR5	F	4	---	---

RECORD # 5 : TRIPPING/CASING TIME-BASED

Logical Record Type : 155

WITS Record ID : 5

Auto/Manual: AUTOMATIC

Trigger : [TIME] Transmit at a specified time interval (secs)

Data Source : Data acquired in real-time and computed over the trigger interval. Only sent when tripping. Average, minimum and maximum values reset when this record OR Record 6 (Tripping/Casing Connection-Based) is transmitted.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	---	---
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	---	---
3	Record Identifier	RECID	RID	S	2	---	---
4	Sequence Identifier	SEQID	SQID	L	4	---	---
5	Date	DATE	DATE	L	4	---	---
6	Time	TIME	TIME	L	4	---	---
7	Activity Code	ACTCOD	ACTC	S	2	---	---
8	Depth Bit (meas)	DEPTBITM	DBTM	F	4	M	F
9	Depth Bit (vert)	DEPTBITV	DBTV	F	4	M	F
10	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
11	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
12	Trip Number	TRIPNUM	TNUM	S	2	---	---
13	In-Slips Status	STATUSIS	STIS	A	2	---	---
14	Hookload (avg)	HKLA	HKLA	F	4	KDN	KLB
15	Block Position	BLKPOS	BPOS	F	4	M	F
16	Running Speed - up (max)	RSUX	RSUX	F	4	M/S	FPM
17	Running Speed - down (max)	RSDX	RSDX	F	4	M/S	FPM
18	Fill/Gain Volume Obs.(cum)	FVOLOC	FVOC	F	4	M3	BBL
19	< SPARE 1 >	SPARE1	SPR1	F	4	---	---
20	< SPARE 2 >	SPARE2	SPR2	F	4	---	---
21	< SPARE 3 >	SPARE3	SPR3	F	4	---	---
22	< SPARE 4 >	SPARE4	SPR4	F	4	---	---
23	< SPARE 5 >	SPARE5	SPR5	F	4	---	---

RECORD # 6 : TRIPPING/CASING CONNECTION-BASED

Logical Record Type : 156

WITS Record ID : 6

Auto/Manual: AUTOMATIC

Trigger : [EVENT] Transmit when first out of slips following a connection

Data Source : Data acquired in real-time and computed from first out of slips to next first out of slips. Only sent when tripping. Average and maximum values reset following the transmission of the record.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	—	—
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	—	—
3	Record Identifier	RECID	RID	S	2	—	—
4	Sequence Identifier	SEQID	SQID	L	4	—	—
5	Date	DATE	DATE	L	4	—	—
6	Time	TIME	TIME	L	4	—	—
7	Activity Code	ACTCOD	ACTC	S	2	—	—
8	Depth Bit (meas)	DEPTBITM	DBTM	F	4	M	F
9	Depth Bit (vert)	DEPTBITV	DBTV	F	4	M	F
10	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
11	Depth Hole (vert)	DEPTVERT	DVER	F	4	M	F
12	Trip Number	TRIPNUM	TNUM	S	2	—	—
13	Connections Done	CONNDONE	CDON	S	2	—	—
14	Connections Remaining	CONNREM	CREM	S	2	—	—
15	Elapsed Time In-Slips	ETIMESLP	ETSL	S	2	SEC	SEC
16	Elapsed Time Out-of-Slips	ETIMEOS	ETOS	S	2	SEC	SEC
17	Running Speed -up (max)	RSUX	RSUX	F	4	M/S	FPM
18	Running Speed -up (avg)	RSUA	RSUA	F	4	M/S	FPM
19	Running Speed -down (max)	RSDX	RSDX	F	4	M/S	FPM
20	Running Speed -down (avg)	RSDA	RSDA	F	4	M/S	FPM
21	Hookload (max)	HKLX	HKLX	F	4	KDN	KLB
22	Hookload (min)	HKLN	HKLN	F	4	KDN	KLB
23	Hookload (avg)	HKLA	HKLA	F	4	KDN	KLB
24	Torque - Make Up (max)	TORQMUX	TQMX	F	4	KNM	KFLB
25	Torque - Breakout (max)	TORQBOX	TQBX	F	4	KNM	KFLB
26	Fill/Gain Volume Obs.	FVOLO	FVO	F	4	M3	BBL
27	Fill/Gain Volume Exp.	FVOLE	FVE	F	4	M3	BBL
28	Fill/Gain Volume Obs.(cum)	FVOLOC	FVOC	F	4	M3	BBL
29	Fill/Gain Volume Exp (cum)	FVOLEC	FVEC	F	4	M3	BBL
30	< SPARE 1 >	SPARE1	SPR1	F	4	—	—
31	< SPARE 2 >	SPARE2	SPR2	F	4	—	—
32	< SPARE 3 >	SPARE3	SPR3	F	4	—	—
33	< SPARE 4 >	SPARE4	SPR4	F	4	—	—
34	< SPARE 5 >	SPARE5	SPR5	F	4	—	—

RECORD # 7 : SURVEY / DIRECTIONAL

Logical Record Type : 157 **WITS Record ID :** 7 **Auto/Manual:** AUTO(MWD)/MANUAL
Trigger : [EVENT] Transmit when new survey data values are received and computed (MWD) or when manually triggered by operator.
Data Source : Data acquired in real-time by MWD tools or entered manually from other sources.

Item	Variable Description	Mnemonic		Rep Code	Byte Length	Units	
		Long	Short			Metric	FPS
1	Well Identifier	WELLID	WID	A	16	—	—
2	Sidetrack/Hole Sect No.	STKNUM	SKNO	S	2	—	—
3	Record Identifier	RECID	RID	S	2	—	—
4	Sequence Identifier	SEQID	SQID	L	4	—	—
5	Date	DATE	DATE	L	4	—	—
6	Time	TIME	TIME	L	4	—	—
7	Activity Code	ACTCOD	ACTC	S	2	—	—
8	Depth Svy/reading (meas)	DEPTSVYM	DSVM	F	4	M	F
9	Depth Svy/reading (vert)	DEPTSVYV	DSW	F	4	M	F
10	Pass Number	PASSNUM	PASS	S	2	—	—
11	Depth Hole (meas)	DEPTMEAS	DMEA	F	4	M	F
12	Svy Type	SVYTYPE	STYP	A	8	—	—
13	Svy Inclination	SVYINC	SINC	F	4	DEG	DEG
14	Svy Azimuth (uncorrected)	SVYAZU	SAZU	F	4	DEG	DEG
15	Svy Azimuth (corrected)	SVYAZC	SAZC	F	4	DEG	DEG
16	Svy Magnetic Toolface	SVYMTF	SMTF	F	4	DEG	DEG
17	Svy Gravity Toolface	SVYGTF	SGTF	F	4	DEG	DEG
18	Svy North-South Position	SVYNS	SNS	F	4	M	F
19	Svy East-West Position	SVYEW	SEW	F	4	M	F
20	Svy Dog Leg Severity	SVYDLS	SDLS	F	4	DGHM	DGHF
21	Svy Rate of Walk	SVYWALK	SWLK	F	4	DGHM	DGHF
22	< SPARE 1 >	SPARE1	SPR1	F	4	—	—
23	< SPARE 2 >	SPARE2	SPR2	F	4	—	—
24	< SPARE 3 >	SPARE3	SPR3	F	4	—	—
25	< SPARE 4 >	SPARE4	SPR4	F	4	—	—
26	< SPARE 5 >	SPARE5	SPR5	F	4	—	—