PPDM Association

Well Logs and Curves Reference Guide

Last updated for PPDM 3.7

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About This Document

This reference guide has been prepared to help managers, analysts, database administrators, programmers, data managers, and users understand how to use the Well Log Data Module in PPDM 3.7. Readers at many levels, from managerial to technical implementers will benefit from reading various sections of this document. General, high-level business information is contained at the beginning of the document, with each section becoming progressively more technical and detailed.

Sometimes the terms we use in this and other PPDM documents need to be defined. We provide definitions in a separate Glossary, which you can obtain from the PPDM Association.

This reference guide contains the following sections:

- Introduction

  Provides an executive overview of the PPDM Model as it pertains to Well Logs.

- Business Process Overview

  Summarizes Well Logs and provides examples of related business processes.

- Integration

  Discusses how Well Logs and curves are integrated with the other PPDM Business Modules and provides information about related references guides.

- Model Overview

  Includes the entity relationship diagram and discusses the use of Module tables in the Data Model.

- Tables and Columns

  Identifies the data model tables for the Module, how they should be used, what they contain, and recommends how they should be used. This section should be used in conjunction with the PPDM Table Report available for download from the PPDM Web Site (www.ppdm.org).

- Implementation Considerations

  Discusses issues related to implementing the PPDM model, architectural methodologies used in design, or special considerations for implementation that are not related to a specific table.

- Frequently Asked Questions

  Addresses technical and business questions about the Well Logs Module.

- Appendix A – Sample Queries

Provides example queries with the appropriate SQL scripts that illustrate uses of the model based on the Business Requirements Document.

Introduction

The first well log was probably acquired by Professor James D. Forbes from the Edinburgh Observatory, when, from 1837 to 1842, he lowered temperature sensors into three shafts in order to record temperature variations with depth and time. This data was later used by physicist Lord Kelvin in calculating the age of the earth.

During the early days of commercial drilling and well logging the only subsurface information recorded was gathered by looking at the sample cuttings brought to the surface. Additional information was recorded such as the rate of penetration, drilling breaks and any events that were relevant. Now the term "Log" is used to describe any data recorded in a well. This data is recorded digitally and presented on a "log" and displayed as a function of depth or time. This data is recorded primarily to determine if a particular formation contains commercial quantities of hydrocarbons. The measurement types have grown significantly over the last decade from basic sonic, resistivity and porosity measurements to now include more sophisticated measurements such as magnetic resonance to help better evaluate the pore space and borehole imaging to help to better understand the structure of the reservoir. Basic formation pressure test measurements have improved and now provide the ability to perform real-time fluid analysis downhole. Uncontaminated samples are taken at in-situ reservoir conditions and returned to surface for additional evaluation.

Acknowledgements

The PPDM Association would like to express its appreciation to IHS Energy and Oilware Inc for their kind permission to use the illustrations contained in this document.

Use of Diagrams in Other Places

While PPDM members may use these diagrams, you are asked to include acknowledgements to IHS Energy and the PPDM Association when reproducing this material. Contact Zane Reynolds (Zane.Reynolds@ihsenergy.com) for more information.

Business Process Overview

Acquisition Methods

There are three methods of acquiring log data:

- Mud Logging
- Wireline Logging
- Measurement While Drilling (MWD, LWD, FEWD)

Mud Logging requires a surface acquisition system and is manned by a team of 2 to 4 persons. During drilling operations, sensors are placed to record various drilling data and samples of the cuttings are caught and analyzed. The information recorded includes:

- Mechanical, hydraulic, and engineering parameters (Depth, ROP, RPM, WOB, Torque, Drilling Mud parameters etc.)
- Drilled cuttings are analyzed to provide geologic data (lithology, fluorescents
- Gas analysis measured from the mud returns

Wireline Logging requires four different types of equipment: the downhole instruments which contain the sensors that measure the data, the surface data acquisition system, the cable or wireline which serves as both mechanical and data communication link with the downhole instruments, and the hoisting equipment to raise and lower the instruments.

Measurement While Drilling (MWD) Logging requires similar equipment to Wireline logging. The primary difference is that the downhole instruments are an integral part of the Bottom Hole Assembly (BHA) so the drilling process acts as the hoisting equipment to raise and lower the instruments. Data transmission usually involves digitally encoding data and transmitting to the surface as pressure pulses in the mud system. Additionally, the data is recorded in memory modules and this data is downloaded once the instruments are retrieved from the well bore.

Post Well-Site Acquisition

Regardless of the acquisition method involved or the deliverable format received some process of identity resolution and data indexing is generally necessary to accurately catalog well log data.

Identity resolution involves verifying the identification of the particular well log making sure that the location information on the log matches a standard such as PI/D Well Information, the 5010 Borehole file from the Minerals Management Service (MMS), existing data in an internal database or any other suitable resource.

Once the well header information has been verified, the well log may be further indexed capturing additional attributes that will aid in classification. Examples of attributes are as follows:

- Service Company
- Service Name
- Log Scale
- Reference
    - Measured Depth
    - Total Vertical Depth
    - Time
- Top and Bottom logged interval
- Logging dates
- Log quality
- Source of the log

Definitions

While the following terms may be described in a number of different ways, these definitions attempt to describe each term in the context of the PPDM model.

Job

A Job encompasses all of the activities performed by a Business Entity (generally a Service Company), while it is engaged by the Operator of the Well to perform services. The scope of services for the Job is generally specified under the terms of a contract or service order. The Job begins when the Service Company arrives at the Well and ends when it leaves. As an example, for a land based well, a Job begins when the Logging Crew arrives in the truck at the well site and it ends when they drive away.

Run

The definition of Run is nearly the same as for a Job with the exception of its scope. The designation of a Run number attempts to track and differentiate between the types of services performed in a Job. An example might be the best way to illustrate the differences between Job and Run. Let's say that a service company is called to a well and performs an induction/sonic from 1000 to 3000 ft. The logging crew leaves and the Job is complete. Then, a week later, the service company comes back and runs another induction/sonic from 3000 to 5000 ft AND runs an FDC/CNL from 4000 to 5000 ft. The FIRST induction/sonic would be RUN 1 and the second induction/sonic would be RUN 2. However, the FDC/CNL, even though it was run during the same JOB as Run 2 of the induction/sonic would be RUN 1. In summary, there were two Jobs and two Runs, but they don't necessarily match up.

Trip

A Trip encompasses all of the activities performed by a Business Entity (generally a Service Company), while a particular Logging Tool String is in the Well borehole. The Trip begins when the tool is inserted into the hole and ends when it is pulled out. Trips exist within the context of a Run and there may be 0, 1, or more Trips per Run.

Pass

A Pass is any continuous recording of sensor readings for the logging instruments within a Trip. A Pass begins when data recording is started and ends when data recording is stopped. For depth based data acquisition, the Tool String is generally moving up or down the Well borehole during a Pass, whereas it may be stationary for time based data acquisition. Passes exist within the context of a Trip and there may be 0, 1, or more Passes per Trip.

Log

A log is a group of one or more curves. These curves, when taken together, are often assigned a name, such as Induction/Sonic, or FDC/CNL. When dealing with digitally delivered well log data, a log is generally synonymous with Pass or File. This definition is a bit vague, but serves as a starting point on which to build.

File

A File is the basic unit of digital well log data interchange. DLIS, LIS, and BIT are multi-file tape formats, which can be encapsulated and created on, or copied to disk as a single physical File. Each logical File within this physical disk File is roughly comparable to the information contained in one LAS File. The basic semantically relevant package of information is the file for ASCII formats or the logical file for DLIS, LIS, or BIT. The File should contain all of the information related to an acquisition Pass.

Parameter

Each file may contain one or more sets of mnemonic/value pairs. Regardless of how this information is semantically related, it is organized in a simple table structure. There are over 13,000 recognized mnemonics which may appear in these tables. Some are easily recognizable and are commonly used, however there are no enforced standards for these mnemonics or their meanings. It is very common to find more than one mnemonic for the same item of information. For example, if one was looking for the temperature at the surface when the well was logged, one would have to search for the mnemonics SHT, ST, STEM, SURFACE_TEMPERATURE, or TSUR. New mnemonics may be added at any time by anyone, and put into use without any prior authorization or warning to the industry. Further complicating matters, some values are intended to be identified as one of a set of possible values. For example, the value for the permanent datum of the well (identified by the mnemonic PDAT), may be found to contain 'GL', 'G.L.', 'GROUND LEVEL' or some other variation (generally in

English), all meaning ground level. Standardization for these sets of values is even less formal than the parameter mnemonics themselves.

Frame

The term Frame has two closely related meanings depending on its context. A "Frame of Data" contains one sample of each curve associated with a specific primary index value (e.g. depth or time). In this case, a sample may be a single value, or a complex multi dimensional array. The primary index is most commonly depth or time, but may be anything. The "Frame Specification" specifies which curves are to be grouped together, the type of the common index (depth, time, etc.), and the sampling characteristics (regular, irregular, spacing between samples if regular, etc.)

The only digital log data format that specifically exposes frames is DLIS. The other formats (LIS, LAS, BIT, etc.) all use frames, but since there is only ever one Frame Specification per File, it is often lumped in with the information about the File. DLIS, on the other hand, provides for multiple Frame Specifications (and consequently, instances of each type of frame specified). This information is important, and must be retained in any system that tracks information about DLIS tapes or files. (Technically, LIS provides a mechanism for recording multiple frame types per File, but this has never been utilized and has therefore been ignored.)

Curve

Also known as a Channel, a Curve is a set of values with a corresponding index (e.g. depth or time) for each value. In digital well log interchange formats, a Curve may be associated with only one Frame. The simplest of curves contains one value for each index value of depth or time. Curves can, however, be very complex entities containing multi-dimensional arrays of data values in each Frame.

Use Cases

Use cases for the PPDM Well Log Model were used to validate the work as the model was developed. The four use cases described below represent cases that were deemed important by the developers of the model. Other uses cases and combinations of use cases are possible, but were not specifically validated.

1. Digital Well Log Data (DLIS, LIS, BIT, LAS) Archival.

DLIS, LIS, BIT, LAS, and other ASCII well log data files are to be managed using the PPDM database. These interchange formats are primarily organized by their physical elements of Files, Frames, Curves, Parameters, and others. The relationship of the information contained in each File is generally associated with a specific Pass, but its relationship to Job, Run, and Trip is not always known or easily determined. Tracking the Well associated with each File is mandatory. All of the necessary information needed to find and retrieve Curves and well site information must be stored in the PPDM database. The data (digits) may be stored in an external file system, or within the PPDM database. There are probably other use cases, but these 4 seem to be the ones under current discussion regarding log data management. Log data acquisition (including activities and equipment) is outside the scope of the current model proposal.

2. Programmatically generated Log Data.

Curves are generated by a program (often referred to as “results data”) are placed directly in the database. There may be no acquisition information associated with the curve and it may only need to be associated with a Well. No external file may ever exist so document tracking is not necessarily required.

3. Well Log Image Archival.

A well log image file or "picture" of the log is to be stored and managed by the PPDM database. Individual Curves depicted are not necessarily tracked, however the "name" or type of the Log depicted, the depth interval or intervals presented and information concerning the location within the image is tracked. The external image file is considered to be a document, which will be managed by the PPDM database, probably in the Records Management Module.

4. Digitized Log Data.

Digitized Log Data is, for all intents and purposes, the same data as described in “Digital Well Log Data.” The primary difference is this data is vectorized (created) from a paper or digital image of the log print. The significance of separating this data is that the quality of the curve is dependant upon the quality of the source document and the vectorization process used to convert the log image to digital curves so the user may choose to handle this data differently than the original tape data.

Curves associated with a Log are digitized as required and associated with a specific Job/Run and Trip. No external data file exists, and hence does not need to be tracked. The organization of Curves into groups as they would have been in acquisition is the same. A paper document or image may need to be tracked.

Digital Well Log Data

Digital Well Log Data is delivered in a variety of formats encoded on a number of mediums. Over the past 30 years, delivery mediums have included all forms of magnetic tape (9-track, 4mm, 8mm, DLT, etc.), Floppy Disk, CD ROM, DVD ROM, FTP, and email, to name a few. Depending on the media used, a number of encapsulation techniques have been utilized to transports formats specific to one medium encoded on another medium. An example of this Tape Image Format (TIF, a.k.a. TAP) was created by Atlas Wireline Services in 1988 for writing tape based formats such as LIS and BIT onto random access media such as hard drives and CD’s. While there have been many formats created for transporting well log data, 5 formats stand out for use in public interchange. These formats are:

- LIS - The Log Information Standard
- DLIS - The Digital Log Interchange Standard
- BIT - The Basic Information Tape
- LAS - The Log ASCII Standard
- WellLogML - The Well Log XML Standard

Since these 5 are the most common and most likely to be loaded into PPDM, they will be described in more detail below.

LIS

The Log Information Standard (LIS) Tape format was developed by Schlumberger in 1974 and is documented in the manual Log Information Standard, Customer Subset dated October 1981, and later revised in 1986. While this standard was never officially adopted by any standards organization, it quickly became the de facto standard for the exchange or delivery of well log data from the late 1970's well into the mid 1990's. Because of its longevity, there is a large volume of data archived in this format on a variety of media.

LIS was designed primarily for use on magnetic tape, but with the use of an encapsulation technique, has been extended to random access media. LIS is a layered format that attempts to define separation among the data content, logical structure and physical structure. In a very simplistic sense, the data is recorded as tables of information stored in a variety of logical records, bound to media using physical records.

DLIS

The Digital Log Interchange Standard V1.00 (DLIS) was introduced on May 1, 1991 as Recommended Practice 66 (RP 66) by the American Petroleum Institute. Version 2.0 was introduced in June 1996, however Version 1.00 is still primarily used for the interchange of well log data. DLIS is probably the best and least well understood means for interchanging well log data. In an extremely simplistic view, it can be thought of as an object-like database, which has been serialized and bound to a sequential format. Like LIS, DLIS too separates data into layers. In order from the lowest to the highest layer, they are Media, Format, Model, Schema, and Dictionary. The first three layers are often referred to as RP66, while the addition of the fourth and optionally the fifth layer constitute DLIS. Other formats (e.g. Geoshare) have been created utilizing the first 3 layers with a modified 4th and 5th layer. The layers are as follows:

- **Media -** This layer is concerned with how data is written to physical media, such as tape, disk, or even communication links. This includes tape marks, and records for tape devices, stream file encoding of data for random access media, and data layer mapping for communications protocols.

- **Format -** This layer is concerned with the low-level organization of the data. This includes the concept of logical records, the mapping of logical records onto physical records, and the representation of numbers, characters and other special data.

- **Model -** This layer specifies the data model supported by RP66. The data model is the application-level view of how data is organized. In a relational database, for example, this is the concept of tables, columns, views, joins, etc. In RP66, two types if data organization is supported. The first type is somewhat object-oriented. An object in RP66 is a self-describing collection of information that represents some entity. This entity may represent a physical thing, or may be an event or activity. The second type of data organization provides for encoding large volumes of sequential data with as little overhead as possible.

- **Schema -** This layer contains the descriptions of the specific objects used by any particular industry or company. The Model layer specifies what an object is; the Schema layer describes what each object contains and all of the objects, which comprise a standard such as DLIS or Geoshare.

- **Dictionary -** The dictionary layer contains two distinct parts. The first part consists of objects used to describe other objects that make up a specific schema. This is similar to the TABLE table and COLUMN table of a relational database. The second part of the dictionary contains the names, definitions, and restrictions placed on the objects.

BIT

The Basic Information Tape (BIT) was created by Dresser Atlas in the 1970's for binding digital well logs onto 9-track tape. Each BIT tape can contain 1 or more files. Each file is composed of only two types of records. The General Heading record contains minimal well identification and information required to read and process the Data records. Each file on the tape begins with one General Heading record and is followed by one or more data records. Each file on a BIT tape may contain up to a maximum of 20 single sampled curves (not including the index channel of depth or time). The data records are all of a fixed length determined by the number of curves present and are recorded in a block multiplexed mode. BIT tapes are not commonly used for the interchange of data today, but are still found in many well log tape archives.

LAS

The Log ASCII Standard was created by the Canadian Well Logging Society in the late 1980's. LAS was intended to supply basic digital log data to users of personal computers in a format that was quick and easy to use. LAS is an ASCII file with minimal header information, intended for optically presented log curves. LAS was designed around a collection of file "sections." Each section began with a title line, and that title line was marked with a tilde ("~") at the beginning of the line. LAS Version 1.2 was fist documented in a paper by the CWLS on

September 1, 1990. LAS 2.0 was published on September 25, 1992, but was fundamentally the same as V1.2 in information content.

The sections that make up LAS Version 1.2 or 2.0 files are as follows:

~V - contains version and wrap mode information

~W - contains well identification

~C - contains curve information

~P - contains parameters or constants (this section is optional)

~O - contains other information such as comments (this section is optional)

~A - contains ASCII log data (always the last section)

LAS Version 3.0, published June 10, 2000 represents a major change to the original LAS concept of simplicity. LAS 3.0 added many new features, including:

1. New Data types. (Core, Drilling, etc.).
2. "Structure" rules separated from "Content" rules.
3. New delimiters and structures.
4. Comma Tab and Space delimited data.
5. 1D, 2D and 3D array handling.
6. Multiple Runs Support
7. Parameter Zoning.
8. Floating point, string, integer, Date and Time formats Support.
9. Addition of User defined data
10. WRAP mode no longer supported.
11. ~Other section removed.
12. 23 predefined "~" section names, with the ability to add an unlimited number of user defined sections.

WellLogML

WellLogML is an XML based, ASCII well Log data format that was designed for exchanging well log data over networks (Internet and intranets). WellLogML (due to the nature of XML) is organized hierarchically into sections as follows:

1. Document Information
2. Well Information
3. Curve Information
4. Parameter Information
5. Downhole Information
6. Other Information
7. Curve Data or Frame Data

Each section is itself composed of subsections identified by Markup tags. The scope and content of a WellLogML file is similar to LAS. Notable features are its ability to handle Array channels, parameter information grouped by run number, and multiple means of curve data organization. The curve data organization options are as follows:

1. **Frames** – This is the most common organization of data in which one sample (single value or array) of each curve is aligned with the index (depth, time, etc.) at which it was acquired. (Same style used by LAS.)

2. **Block Multiplexed Frames** – This organization allows for multiple samples of each curve to be grouped into separate identifiable blocks.

3. **Curve Sequential** – This organization is not commonly used in log analysis software, but it is particularly useful for files that are intended to be rendered graphically. The curves are organized such that all samples of the index curve are grouped together, followed by all samples of each dependent curve.

4. **Block Multiplexed Curve Sequential** – This organization allows for each curve to be broken down into multiple, identifiable, groups of samples.

Programmatically Generated Log Data

To further enhance the usefulness of digital well log data, advanced analysis is often required. New algorithms are continually developed to attempt to garner greater understanding of rock and fluid properties. The "results curves" of this analysis may be stored along with the raw data or as a separate log.

Well Log Image Data

A Well Log Image may be described as a computerized picture of a well log. Digital vector data is graphically presented in a form that is meaningful for a geoscientist to perform analysis. The origin of the well log image file may be a scanned paper plot or an image rendered using digital curve data. For example, some applications allow a user to import digital log data, view, annotate and output the resulting image to a variety of graphic file formats including PDF, BMP, JPEG, CGM and TIFF.

Today, information is being captured and added to these image files significantly enhancing their value. Very often the well log is characterized with respect to the image representation itself. That is, data about the well log within the context of the image file is recorded and stored. For instance, the key positions within the image file of various parts of the well log may be recorded.

Calibration or registration of a well log image may be performed in any number of ways. For instance, a well log image may contain a number of sections representing a variety of section types. Section types could be defined in any number of ways. The following figure depicts one fairly simple example of the types of sections in a raster, well log image:

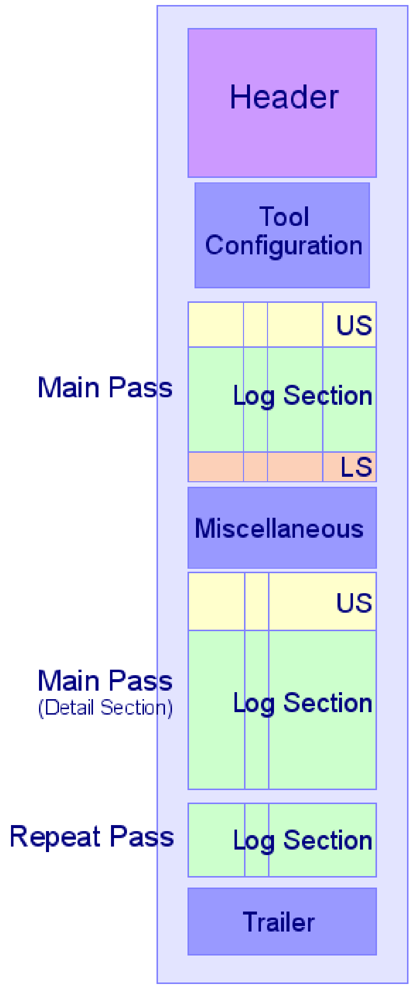

Diagram used by permission of IHS Energy.

In the figure above well log sections could be defined as:

- Header
- Tool String Configuration
- Upper Scale
- Lower Scale
- Log Sections
- Trailer
- Miscellaneous

Log sections could be further classified as:

- Main Pass
- Uplog
- Downlog
- High Resolution
- Repeat Pass, etc.

For well log image calibration, it's important to capture a number of points in order to accurately represent those sections of a well log image deemed interesting. In the following example, non-depth related X, Y value pairs could be captured for the Header and Parameter sections of the well log image:

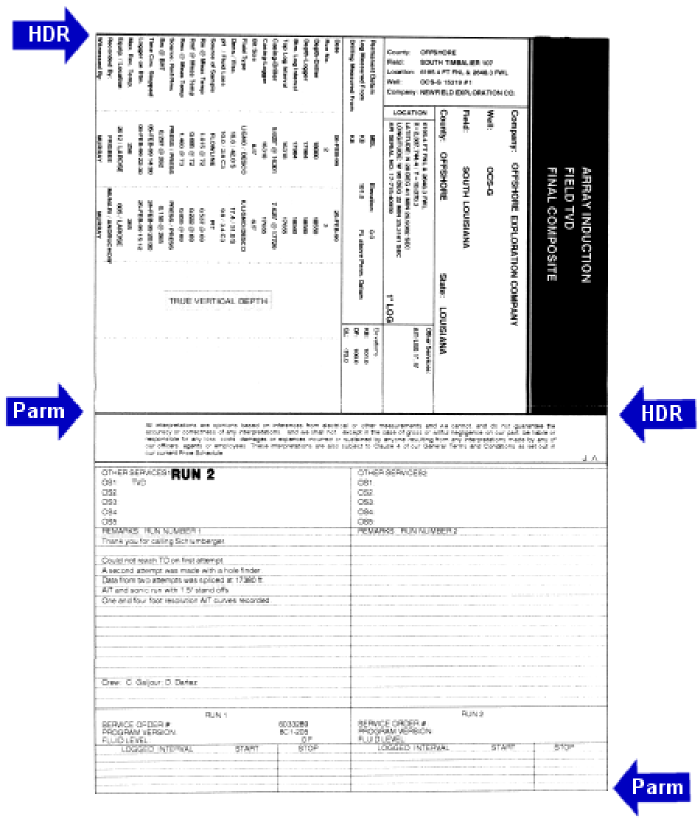

Diagram used by permission of IHS Energy.

The most common calibration information obtained is a depth registration in which X and Y pixel values are captured at each depth of interest within a well log section. In the first diagram below, X and Y value pairs are recorded and stored with several key depths. However, many X and Y value pairs could be stored with each depth captured to further represent the well log image and lend accuracy to the end user's analysis process. Furthermore, these extra points are useful for identifying and correcting problems such as skew and paper stretch that may have occurred during the scanning process.

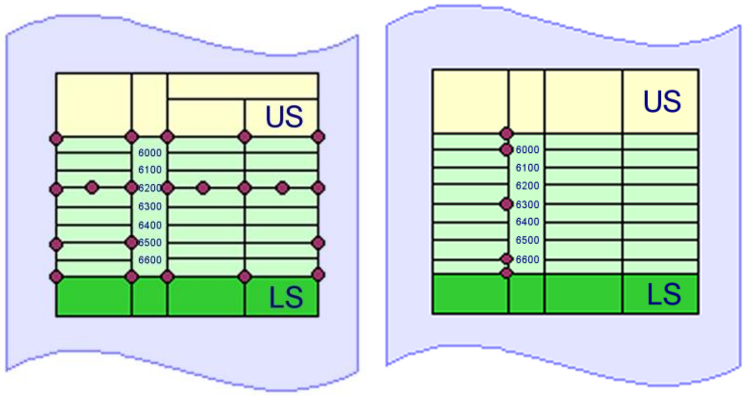

Diagram used by permission of IHS Energy.

The following partial well log image depicts a possible calibration scenario. X, Y value pairs associated with depths in a log section are represented by the diamond shape while arrows represent possible X, Y values of interest that are not related to depth values. In this instance, the top-left and bottom-right X, Y values have been captured for both the upper and lower, horizontal scale sections.

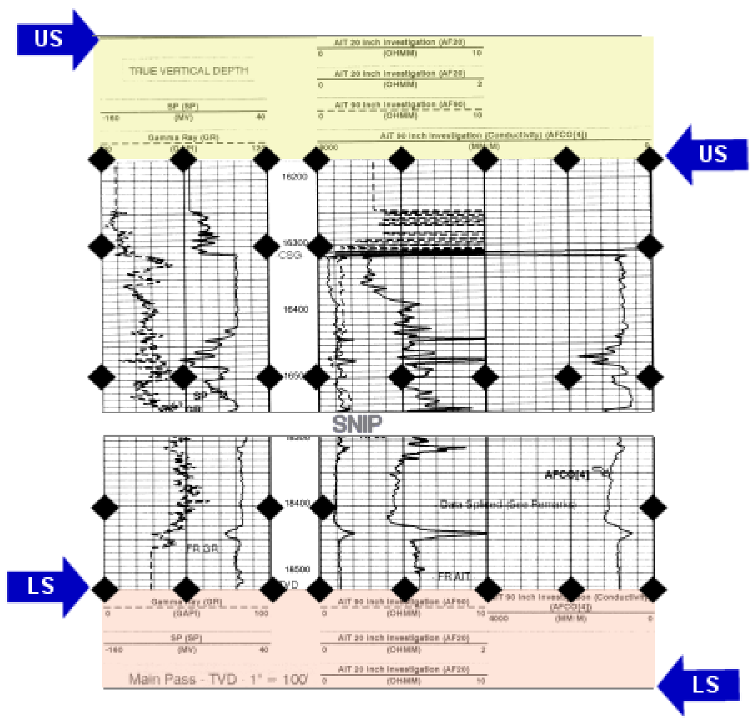

Diagram used by permission of IHS Energy.

Additional sections of the well log may be delineated that again do not include an associated depth value. For instance, it is often very useful for geoscientist to view the tool configuration diagram while processing the well log. The following example illustrates the points that might be captured to lend easy access of the tool configuration section:

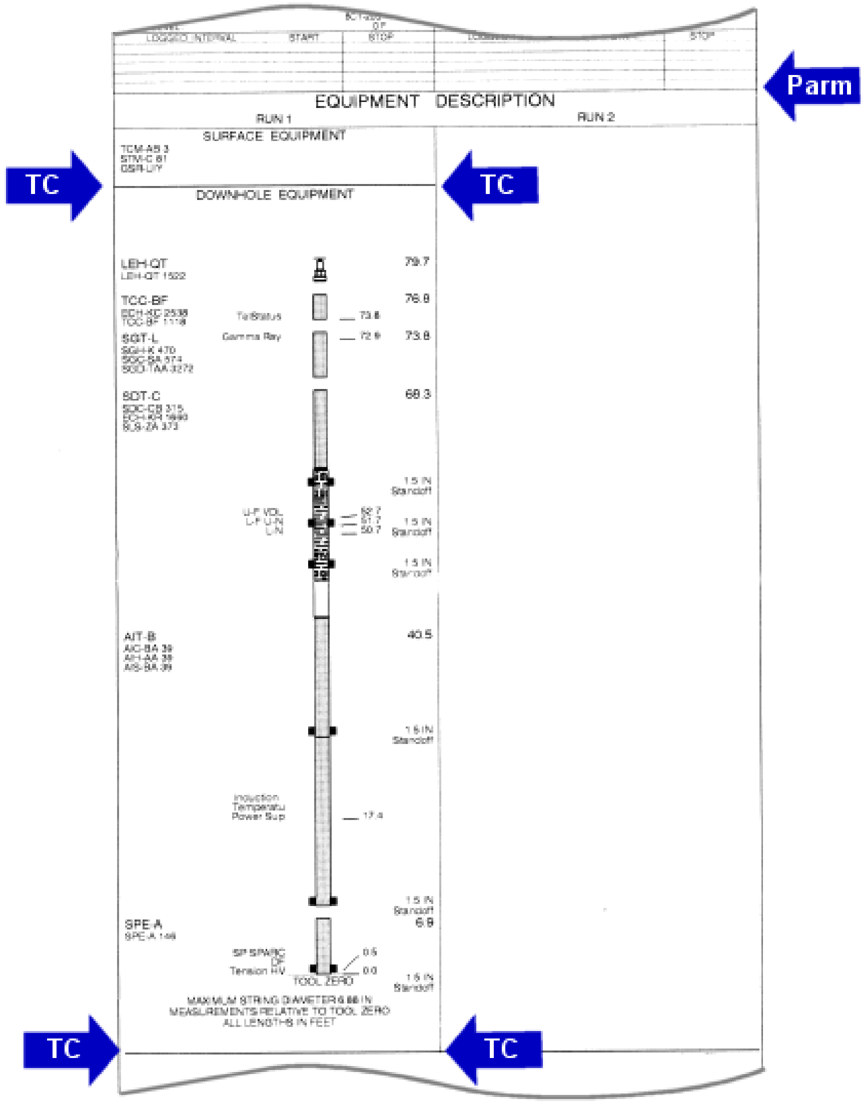

Diagram used by permission of IHS Energy.

In the next example, X, Y values are captured for these sections:

- Lower Scale
- Parameter Section
- Trailer

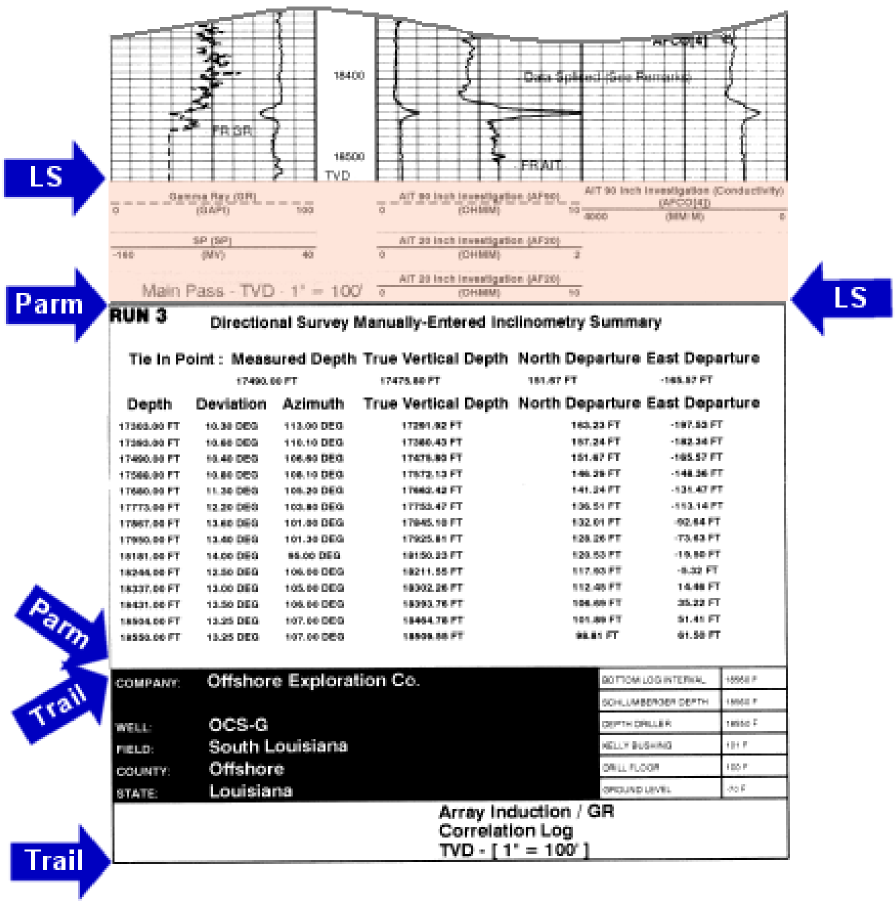

Diagram used by permission of IHS Energy.

Digitized Log Data

Digitizing paper log plots is another means of obtaining digital log data. Since the digital log provides the ultimate data set with no hindrance to performing any log analysis functions that are present with images or paper logs, it is often necessary to digitize curves when the digital version is unavailable. The digitizing process has been around for quite some time and will be covered only in general terms in this guide. Digitizing became a commercial process in the late 1970's but remains a very specialized service. A typical modern digitizing process may include identity resolution, data entry of the well header and run parameter data, scanning the log, grid detection and curve vectorization.

Header Entry

To enable the usage of a digitized log to its fullest, additional information on the log must be captured. The well header information including location and elevation information and all run parameter data must be captured and stored with the log curves. The quality of analysis and environmental correction operations may be diminished in the absence of this information.

Scanning the Log

Typically a log is scanned using specialized scanning software and hardware designed to accommodate very long documents not typically encountered outside the industry.

Grid Detection

Grid Detection is a method by which the digitizing software identifies and quantifies the grid of a log section. During grid detection, an operator supplies key information for each track to be digitized. The software attempts to optically sense the track's grid. In the example below, nodes are assigned to each grid line intersection. The operator then reviews and modifies the nodes assigned by the software until an optimal result is achieved. In this manner, the grid pixels can be discerned from the actual curve trace pixels.

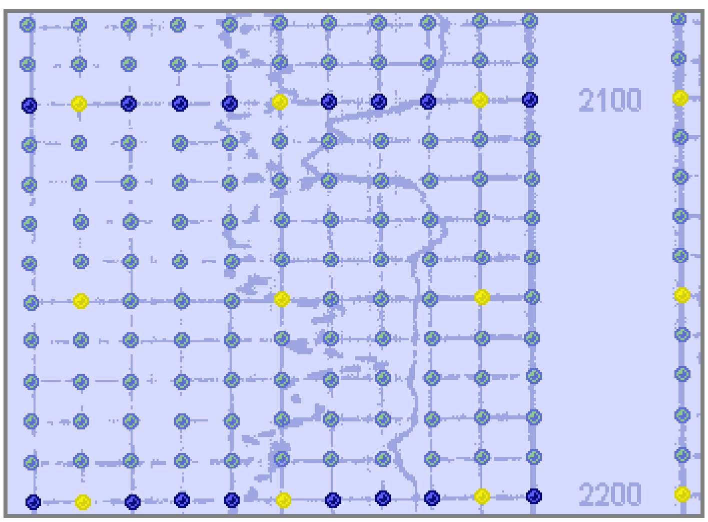

Diagram used by permission of IHS Energy.

Curve Vectorization

Curve vectorization is the process by which a sequence of vectors is generated corresponding to the individual well log curve traces. Vectors are applied along all continuous lines on the well log image. Only the grid lines are ignored as a result of being defined as such during the grid detection process described above. The following image depicts the results of the automated vectorization process:

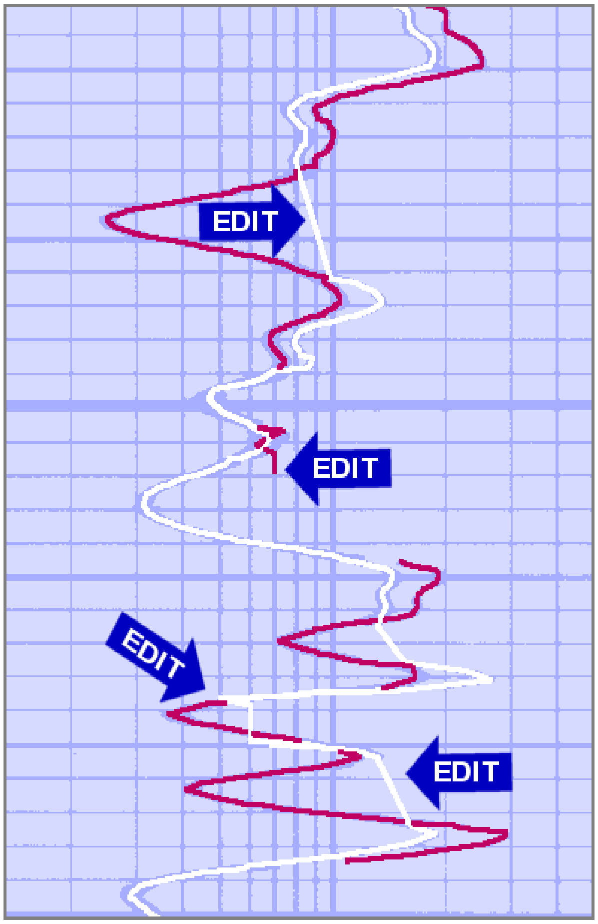

Diagram used by permission of IHS Energy.

After automated vectorization, an operator must visually inspect the resulting curve vectors and correct all problems that may have resulted from overlapping curve traces or poor well log image quality.

Once digitized, the resulting log data can be used in any way that originally captured digital log data may be used.

References

Luthi, Stefan (2001) The History of Logging (taken from the book: Geological Well Logs, their use in reservoir modeling, Springer-Verlag)

Model Overview

Integration

Integration is the key to managing the PPDM Data Model properly. Information critical to managing data throughout its life cycle is managed in many support and business modules in PPDM version 3.7:

Support Modules

Business Associates: track detailed information about partners, service providers and other people, companies and regulatory agencies that you do business with.

PPDM Unit Measure: captures the default stored unit of measure for any measured value in the database and conversion factors.

Entitlements: information about the rights that you have to any type of data and what you are able to do with it.

Business Modules

BA Interest Sets: describe partnership information for the ownership of wells or other business objects.

Stratigraphy: make use of subsurface stratigraphic definitions that can be shared among all modules.

Projects: track work projects related to the development of reserves, or track reserve additions resulting from a specific project.

- Records Management: track the physical location of digital and hard copy products, circulation, retention, etc.
- Wells: describe in details wells that are part of the reserve entity.

Contact PPDM to inquire about the status and availability of reference guides for these modules.

Data Diagrams

The diagram on this page is the legend for the tables discussed later in this document. Note that some or all of these elements may be present in data diagrams provided by the Association. Some elements are removed from final products to reduce file size:

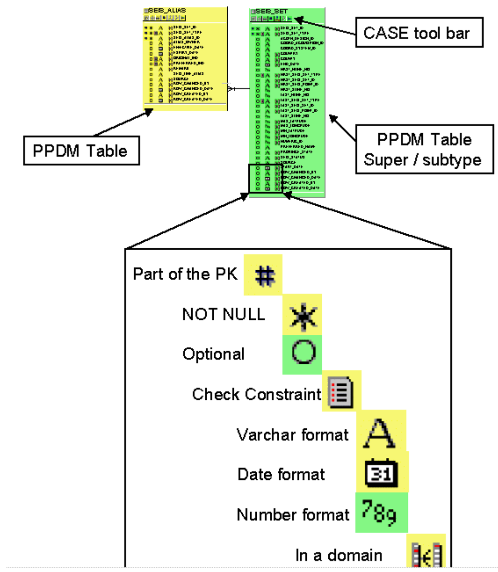

Figure 6: *This illustration shows the functions of each icon used in the data diagrams provided with PPDM version 3.7.*

The data diagrams for the Well Logs Module are not provided in this reference guide because of their very large file size. Data diagrams can be obtained from the PPDM Association as part of the final model documentation or as a set of PowerPoint diagrams. The PowerPoint diagrams will provide the best resolution for printed quality.

Tables and Columns: Well Logs

The following tables exist in the Well Log module of PPDM version 3.7. Each table is described in the following section; you can jump to a table description by clicking on the hyper-linked table name below. Note that for detailed content descriptions for each table, you should refer to the PPDM version 3.7 table documentation.

WELL_LOG
WELL_LOG_AXIS_COORD
WELL_LOG_CLASS
WELL_LOG_CLS_CRV_CLS
WELL_LOG_CRV_CLS_XREF
WELL_LOG_CURVE
WELL_LOG_CURVE_AXIS
WELL_LOG_CURVE_CLASS
WELL_LOG_CURVE_FRAME
WELL_LOG_CURVE_PROC
WELL_LOG_CURVE_SCALE
WELL_LOG_CURVE_SPLICE
WELL_LOG_CURVE_VALUE
WELL_LOG_DGTZ_CURVE
WELL_LOG_DICTIONARY
WELL_LOG_DICT_ALIAS
WELL_LOG_DICT_BA
WELL_LOG_DICT_CRV_CLS
WELL_LOG_DICT_CURVE
WELL_LOG_DICT_PARM
WELL_LOG_DICT_PARM_CLS

WELL_LOG_DICT_PARM_VAL
WELL_LOG_DICT_PROC
WELL_LOG_IMAGE_COMP
WELL_LOG_IMAGE_LOC
WELL_LOG_IMAGE_SECT
WELL_LOG_JOB
WELL_LOG_PARM
WELL_LOG_PARM_ARRAY
WELL_LOG_PARM_CLASS
WELL_LOG_PASS
WELL_LOG_TRIP
WELL_LOG_TRIP_REMARK

RM_INFORMATION_ITEM
RM_PHYSICAL_ITEM
RM_INFO_ITEM_CONTENT
RM_FILE_CONTENT
RM_IMAGE_COMP
RM_IMAGE_LOC
RM_IMAGE_SECT

Well Log Dictionaries

Logging companies provide lists of the standard mnemonics that are used during logging operations; these lists are contained in the well log dictionaries in PPDM. Each logging contractor may have one or more dictionaries in use at a given time and may add or deprecate dictionaries over time. Three types of values may be managed in the dictionary.

- Curve mnemonics indicate the type of data being recorded.
- Parameters provide detailed meta data about the well logging operation.
- Processing indicators describe technical manipulation or processes applied to the data during recording or a post processing session.

WELL_LOG_DICTIONARY

This is a header table. The name of the dictionary and the dates that the dictionary is used are captured. Subordinate tables allow you to capture lists of the parameters, processing indicators and curves in that dictionary.

Back to the list of table names

WELL_LOG_DICT_ALIAS

All names, codes and identifiers for a well logging dictionary may be loaded into this table. Preferred versions can be denormalized into the WELL LOG DICTIONARY table (PREFERRED NAME) if desired. This table tracks the owner for each alias and the dates that the alias name or code was in use. The reason why the alias was created may also be captured.

Use this table when loading data from digital well log information to identify the well log dictionary used for the data.

Back to the list of table names

WELL_LOG_DICT_BA

This table is used to list the companies that use a well log dictionary over a period of time. For each logging contractor that uses the dictionary, you may capture the name or code they typically used to identify the dictionary; this information may be useful when deciding which dictionary was used by the contractor for a given well log.

Back to the list of table names

WELL_LOG_DICT_CURVE

This table contains a list of the curves and associated mnemonics that are contained in the referenced dictionary. Mnemonics and descriptions for each curve are provided, together with information about when that particular mnemonic was in use.

Back to the list of table names

WELL_LOG_CURVE_CLASS

This table contains a list of curve classifications. These classifications are used to group well log curves based on any type of criteria, usually the property type of the curve. Typical examples include gamma ray, neutron, resistivity, caliper, density etc.

Note that this table is not owned by a dictionary, but is used to classify curves across all dictionaries. This table can be used to support the hierarchical relationships between curve classifications, particularly when used in conjunction with WELL LOG CRV CLS XREF.

Back to the list of table names

WELL_LOG_DICT_CRV_CLS

This table is used to associate the well log curve mnemonics defined in WELL_LOG_DICT_CURVE with the generalized classifications defined in WELL LOG_CURVE_CLASS. Consequently, each curve may belong to one or more curve classes. This table is used to assist with searches such as "find all of the density curves, regardless of the mnemonic used".

Back to the list of table names

WELL_LOG_DICT_PARM

This table contains a list of the parameters supported by each well log dictionary and the mnemonic used. There are over 13,000 recognized mnemonics that may appear in these tables. Some are easily recognizable and are commonly used, however there are no enforced standards for these mnemonics or their meanings.

It is very common to find more than one mnemonic for the same item of information. For example, if one were looking for the temperature at the surface when the well was logged, one would have to search for the mnemonics SHT, ST, STEM, SURFACE_TEMPERATURE, or TSUR.

Back to the list of table names

WELL_LOG_PARM_CLASS

This table allows you to group or classify parameters in any way necessary. For example, if one were looking for the temperature at the surface when the well was logged, one would have to search in the table WELL LOG DICT PARM for the mnemonics SHT, ST, STEM, SURFACE_TEMPERATURE, or TSUR.

Alternatively, you may create a SURFACE TEMPERATURE class in WELL LOG PARM CLASS and then associate that class with the various temperature parameters using WELL LOG DICT PARM CLS. You might also create a class of parameters that are typically found in the well log header.

This table is not owned by any particular well log dictionary; classes are independent and can be used across dictionaries.

Back to the list of table names

WELL_LOG_DICT_PARM_CLS

This table is used to associate the well log parameter classifications with actual parameters defined in the well log dictionary. Note that any parameter may belong to one or more classes.

Back to the list of table names

WELL_LOG_DICT_PARM_VAL

This table is used to store recommended or allowable values for a specific parameter. For example the mnemonic for borehole status (BHS) may only assume the values of CASED or OPEN. Note that this information is stored using the standard mnemonic value size, varchar2(255), even though actual values may be considerably smaller or even a numeric data type.

Back to the list of table names

WELL_LOG_DICT_PROC

This table defines the processing indicators used in a well log dictionary. These are typically shown as present (the processing step was completed) or not present (the processing is assumed to not have been completed).

In practice, an indicator that is not present may or may not have been completed, but well log data will rarely provide the user with explicit lists of processes that are not completed.

Back to the list of table names

Well Digital Logs and Curves

This set of tables may be used to explicitly store all the information extractable from a digital well log or curve file, including header information and actual curve digits. All common well log types are supported, including LIS, LAS and DLIS.

WELL_LOG

A well log may be composed of a group of one or more curves. These curves, when taken together, are often assigned a name, such as Induction/Sonic, or FDC/CNL.

When dealing with digitally delivered well log data, a log is generally synonymous with Pass or File. The WELL LOG table allows you to capture general information about the well log, such as the type of index (usually depth or time), references to the acquisition information, top and base depth of the logged interval and the dictionary that was associated with the log.

Back to the list of table names

WELL_LOG_CURVE

Also known as a Channel, a Curve is a set of values with a corresponding index (e.g. depth or time) for each value. In digital well log interchange formats, a Curve may be associated with only one Frame. The simplest curves contain one value for each index value of depth or time. Curves can, however, be very complex entities, containing multi-dimensional arrays of data values in each Frame.

This table may be used to capture the curves defined in a log, or to capture curves that exist for a well without reference to a log. Statistical information about the curve, such as number of samples, the minimum and maximum values, median, standard deviations etc are managed. Summary acquisition or creation information, such as whether the log is a composite curve, acquired during a by-pass operation or in a cased hole, may be stored in this table. Additional information about the logging tool or acquisition of the curve may also be referenced from this table.

[Back to the list of table names]

WELL_LOG_CURVE_AXIS

Details about multidimensional axis may be stored in this table, including the number of dimensions in an axis, the name and spacing of the axis and the units of measure used for the axis.

[Back to the list of table names]

WELL_LOG_AXIS_COORD

Individual coordinates along the axis of the curve may be stored in this table. Note that the coordinates are stored as text values in character format. Coordinates may be sorted into appropriate sequences for retrieval by using the column COORDINATE SEQ NO.

[Back to the list of table names]

WELL_LOG_CLASS

This table allows each well log to be associated with one or more well classifications. A valid list of classifications to be used may be found in the table R_WELL_LOG_CLASS.

These classifications may be atomic in nature or composite, depending on the nature of your business. For example, a log of class Induction/Sonic may be classified as Induction and as Sonic or as the composite value. For most implementations, atomic classifications will likely be most useful.

[Back to the list of table names]

WELL_LOG_CLS_CRV_CLS

This table is used to cross reference well log classifications with well curve classifications. It may be used to assist with searches for curves that are contained in specific logs, or to group curve or log classifications.

[Back to the list of table names]

WELL_LOG_CRV_CLS_XREF

This cross reference table is used to support the creation of a hierarchy of curve classifications. For example, resistivity logs may also be classified as shallow resistivity or deep resistivity.

[Back to the list of table names]

WELL_LOG_CURVE_FRAME

The "Frame Specification" specifies which curves are to be grouped together in a digital file, the type of the common index (depth, time, etc.), and the sampling characteristics (regular, irregular, spacing between samples if regular, etc.)

The only digital log data format which specifically exposes frames is DLIS. The other formats (LIS, LAS, BIT, etc.) all use frames, but since there is only ever one Frame Specification per File, it is often lumped in with the information about the File. DLIS, on the other hand, provides for multiple Frame Specifications (and consequently instances of each type of frame specified). Frames are explicitly defined in the DLIS format, so that more than one frame may exist in a file. In other formats, such LIS and LAS, the Frame is implicit since there is only one frame per file.

When populating the WELL LOG CURVE FRAME table for non-DLIS formats, treat this table as if it contains a 1:1 relationship with the WELL LOG table. Important information, including the curve spacing, direction of logging, interval traversed and indication of whether the spacing is regular or irregular is stored in this table.

[Back to the list of table names]

WELL_LOG_CURVE_PROC

A listing of the processing indicators for a well log may be captured in this table. You have the option of storing the reported mnemonic for the processing indicator only or of also capturing which processing indicator in the dictionary is intended. Reported information for well logs often does not conform to the standard mnemonics for the dictionary used, but for some purposes it is necessary to reconstruct exactly what was provided by the logging contractor.

[Back to the list of table names]

WELL_LOG_PARM

A listing of the parameters assigned to a well log may be captured in this table. You have the option of storing the reported mnemonic for the parameter only or of also capturing which parameter in the dictionary is intended. Reported information for well logs often does not conform to the standard mnemonics for the dictionary used, but for some purposes it is necessary to reconstruct exactly what was provided by the logging contractor.

Information about the order in which the parameter was reported, the format to be used when outputting this parameter and its text or numeric value are supported. Units of measure are explicitly stored rather than concatenated with the value of the parameter.

Note that many parameters may be mapped to other table locations in the well data model. These mappings are provided between LAS 3.0 and PPDM and are available on the PPDM web site (www.ppdm.org). This table does not rely on these mappings, but allows information as provided on the well log to be captured exactly as provided. Comparisons to actual values in the well tables may be useful as a quality control devise.

Back to the list of table names

WELL_LOG_PARM_ARRAY

Some well log parameters are provided as arrays of values; this table may be used to store the information contained in that array. Values may be captured in text or numeric form and units of measure are explicitly stored. Details about the dimensionality and order of the elements may also be captured.

Back to the list of table names

WELL_LOG_CURVE_VALUE

This table is used when storing the actual index / value pairs measured along a curve. Note that you have two other choices for storing actual curve information – you can provide a pointer to the file location of the digits or you can store the actual LIS, LAS or DLIS file in the database. Both of these alternate functions are managed in the Records Management module. Please refer to the Records Management reference guide for details.

Back to the list of table names

Well Digitized Logs and Curves

Digitized curves are managed in PPDM in addition to digital curves and curve images. Details about the creation of the digitized curve are supported. Pointers to the actual digitized curve are supported in the Records Management module.

WELL_LOG_DGTZ_CURVE

This table describes some details about the digitization of the curve, including the date the curve was digitized, the depth increment that was acquired, how null values were represented, the depth correction method used and the quality of the curve.

Back to the list of table names

WELL_LOG_CURVE_SCALE

Use this table to define the scales of the curve, the transformation types and details about the tracks acquired. The depth interval for each scale application is also stored.

Back to the list of table names

WELL_LOG_CURVE_SPLICE

This table references which sections of other curves were used in the construction of this curve. In each case, the input curve may be a digital curve or a curve file referenced from the Records Management module. The minimum and maximum index value inserted into the new curve is stored.

[Back to the list of table names]

Well Raster Logs and Images

Well log image files are managed in the PPDM database, using the Records Management module. Details about the construction of the raster log and its contents are managed in the well log module. Details about the physical rendering of the raster log (tiff image etc) are managed in the Records Management module.

RM_INFORMATION_ITEM

The PPDM Records Management module distinguishes between the information contained on or in a product and the physical rendering or manifestation of the information. This table tracks the information that is contained in a product. For the purposes of this document, the information would normally be a well log or curve. This table is a super-sub type table set – please refer to the Records Management Reference guide for more details about this. For the purposes of this document, the sub type will probably be RM_WELL_LOG (note that it could be different).

If you are tracking the location of a well log file, whether it is on paper, film, tape or digital, you must start by creating a row in this table and its valid sub-type.

[Back to the list of table names]

RM_PHYSICAL_ITEM

This table keeps track of information about the physical rendering of a copy of information. Note that a single well log may have many renderings (paper, tif image, film image etc.). Summary information about digital raster image is stored in this table. This includes file size, color depth, format and so on.

Some raster images are broken down into components for storage and handling (such as a header section, curve section, scale section, diagram section etc.). You can choose whether to store each section of the image as a separate physical item – it depends on what you want to do with the information later on. The tables RM_IMAGE% can be used to track information about the various sections in the raster image.

[Back to the list of table names]

RM_INFO_ITEM_CONTENT

This table can be used to connect the well log rendering and products with detailed technical information about the well log or curve. Use the foreign key relationship to attach the information item to the log or curves that are included in this product.

Back to the list of table names

RM_FILE_CONTENT

This table contains a blob that can be used to store the actual digits of a tiff or other image file. Use when you prefer to store products inside the PPDM database, as opposed to providing a pointer to the physical location on a file server or tape stack or file cabinet.

Back to the list of table names

RM_IMAGE_SECT

Each well log image file can be deconstructed into logical sections, such as a header, one or more upper and lower scales, log data at various scales or well diagrams. This table lists the sections that the image is composed of. Details about the depth of the section, the length and interval of the scale for the section, the matrix type observed, calibration details etc are all managed here. Use only the columns that are useful for each type of section that you are managing.

The WELL LOG IMAGE COMP table will be used to group the sections into logical groups. You can facilitate this grouping in one of two ways:

- Store only atomic component sections in this table.
    - Upper scale
    - Lower scale
    - Log section
- Store atomic component sections in this table and add rows for each of the logical groupings you will create. This is the preferred method.
    - Upper scale
    - Lower scale
    - Log section
    - Scale group

Back to the list of table names

RM_IMAGE_COMP

Use this table to group sections in the well log image into logical groups. For example, an upper scale, a lower scale and a log section may be grouped together. The order in which components are to be placed for use can be stored in COMPOSITE SEQ NO.

- If you are storing atomic components only, group as follows
    - Log section with the Upper Scale
    - Log Section with the Lower Scale

- If you are also capturing the logical grouping as a section, group as follows:
    - Scale group with the Upper Scale
    - Scale Group with the Lower Scale
    - Scale Group with the log section

Back to the list of table names

RM_IMAGE_LOC

This table captures location information for each section on the log. Some companies store only the pixel row in which the section starts and ends. Other companies store pixel row and column (X and Y) information.

You may also use this table to capture details about the depth corrections for log sections. In this case, capture the LOG DEPTH in conjunction with the X and Y positions on the image. Use the column POSITION TYPE to differentiate between positions that locate the section on the image and positions used for depth calibration.

Back to the list of table names

Well Log Acquisition

Details about the acquisition of the well log are captured in this set of tables.

Back to the list of table names

WELL_LOG_JOB

This table captures information that is common to a set of logging operations. The “job” is usually conducted by a contractor at the wellsite when drilling has been halted at a strategic depth and the drill string removed from the wellbore. The start and end dates of the job, the total depth of the wellbore, and the depth of deepest casing can be recorded here.

Back to the list of table names

WELL_LOG_PASS

This table captures information about an individual pass during the well log trip. Information about the interval covered during the pass and the start and end time are captured. The pass number assigned by the logging contractor may be captured, but is not part of the primary key.

Back to the list of table names

WELL_LOG_TRIP

This table contains information about the tool used in one operating cycle down the well, from the time it is lowered to the time it is retrieved. The primary key includes JOB_ID and LOG_RUN (number). The logged interval is defined by the bottom and top depths. A single trip may have more than one pass of the interval; these are captured in the table WELL_LOG_PASS.

There can be only one tool string for a trip, because the configuration cannot be changed down the hole. The tool string may contain several sensing devices (tools), each measuring several properties (recorded as curves).

The LOG_RUN column has not been renamed to conform to the current architectural principles. It is analogous to RUN_NUM, as used in WELL_TEST and other tables. This column may be captured as reported by the logging contractor and is not part of the primary key.

The CURVE_TYPE column identifies the type or category of the measured property, such as acoustic velocity or resistivity. The specific property, such as deep induction resistivity, is captured in table WELL_LOG_CURVE. The CURVE_TYPE, therefore, is related to the tool used for the trip and should be defined in the reference table R_LOG_TOOL_TYPE. The WELL_LOG_TRIP table only tells what curves are possible for this trip; the actual recorded properties and the logged intervals must be entered in other tables.

Samples of the drilling fluid may be taken and analyzed for properties needed for calibration and interpretation of the log curves. The MUD_SAMPLE_ID, type, and source are foreign keys to the WELL_MUD_SAMPLE table.

[Back to the list of table names]

WELL_LOG_TRIP_REMARK

The table captures narrative remarks about the well log trip. These comments may be made by the field crew, processing house, or interpretation specialists at any time, and could comment on the quality of the logs, field conditions, or problems.

[Back to the list of table names]

Implementation Considerations

Constraints in PPDM

It is essential that anyone who is considering using PPDM version 3.7 review the Constraints Reference Guide first. Improper use or population of constrained columns in PPDM can compromise the quality of your data and the reliability of your queries. This document may be obtained from the PPDM Association or downloaded from the PPDM web site at www.ppdm.org.

Check Constraints

PPDM version 3.7 makes use of check constraints in rare cases where the values that may be input for a column are known at design time and will not change over time. Two types of uses are observed in PPDM 3.7.

- Where the column name is %_IND, the column is an indicator field, and the values may only be Y, N, or null.

- Super-sub type implementations use check constraints to enforce the integrity of the super-sub type relationship. Currently these relationships are in use for, Seismic Sets, Records Management, Support Facilities, Production Entities and Land Rights.

  Let's use Seismic Sets as an example. This structure consists of a parent table (SEIS_SET) and eight sub-type tables (SEIS_3D, SEIS_ACQTN_SURVEY, SEIS_INTERP_SET, SEIS_LINE, SEIS_PROC_SET, SEIS_SEGMENT, SEIS_SET_PLAN and SEIS_WELL). Each of the tables has a two-part primary key: SEIS_SET_ID and SEIS_SET_TYPE.

  SEIS_SET_ID is assigned by the user and can have any value as long as it is unique for that type of Reserves set. SEIS_SET_TYPE was designed to maintain the integrity of the super-sub type structure and can only have the values assigned to it by check constraints; these values are the table names of the eight valid sub-types. In SEIS_SET, the SEIS_SET _TYPE can have any of the table names, but in each of the sub-types, it can only have the name of the table it is owned by.

Currencies in PPDM

Costs in PPDM may originate in any valid Unit of Measure (UOM), such as USD, $CDN, YEN, etc. However, to ensure that queries for retrieval and reporting are efficient, it is desirable to convert all original currencies to a standard unit of measure for storage in the database. PPDM supports the requirement to restore the original value in the following way:

- Convert all stored currencies to a single currency type, such as US dollars.
- CURRENCY_OUOM stores the currency in which the funds were initially received. When the stored currency is multiplied by the CURRENCY_CONVERSION, the value of the transaction in the original currency is obtained.
- CURRENCY_CONVERSION stores the rate applied to convert the currency to its original monetary UOM from the stored UOM. This value is valid for this row in this table at the time of conversion only. When this value is multiplied by the stored currency value, the original value of the transaction in the original currency is restored.

Units of Measure

Relational databases, powerful as they are, are not good at certain types of query and retrieval. Any time a query is developed that requires the database to retrieve all the rows in a large table and perform some calculations on the data before returning results to a user is likely to perform very poorly. This assumes, of course, that the person constructing the query is aware that a calculation is necessary when writing the query. Data management strategies for such tables recommend that requirements for on-line conversions such as this be eliminated if at all possible. The PPDM strategy for handling units of measure falls into this category.

Every column in the data model that references a Unit of Measure (such as a depth, temperature, length etc.) should be stored using a single, common unit of measure. For example, in one PPDM instance, all the total well depths should be stores as meters or as feet. Storing some depths as meters and the rest as feet creates problems for the data base and adds confusion to the user (who may not be aware that the numbers in the DEPTH column are not all meters).

The original unit of measure (the unit in which the data was originally received) can be stored in the data table. For example, the WELL table captures FINAL_TD and FINAL_TD_OUOM. These columns capture the value of the final total depth of the well and the units that the depth was originally captured in.

The ***stored unit of measure*** is captured in the PPDM meta model, PPDM_COLUMN. This table captures the default unit of measure for a column and the name of the column where the original unit of measure is stored. The following illustration provides an example:

WELL

UWI	DRILL_TD	DRILL_TD_OUOM
SMITH12F	1250	ft
JONES44	1560	m
12345	1400	ft

PPDM_COLUMN

TABLE_ NAME	COLUMN_ NAME	UOM_ COLUMN	OUOM_ COLUMN	DEFAULT _ OUM_ SYMBOL
WELL	UWI			
WELL	DRILL_TD		DRILL_TD_OUOM	m
WELL	DRILL_TD_OUOM			
WELL_CEMENT	CEMENT_AMOUNT	CEMENT_AMOUNT_UOM	CEMENT_AMOUNT_OUOM	

Figure 9: *The method for storing and tracking units of measure is illustrated here..*

Note that in the example, the Drilling TD is stored in meters, but was originally received as feet. In some cases, it is not possible to ensure that all the rows in a column are stored as a single unit of measure – this is common in cases where the unit of measure is dependent on some other factor. For example, substance measurements may depend on the substance being measured; gases are stored as MCF, liquids as BBL etc. In these cases, the unit of measure is stored directly in the business table.

Audit Columns

Each table contains five columns: SOURCE, ROW_CHANGED_BY, ROW_CHANGED_DATE, ROW_CREATED_BY, and ROW_CHANGED_DATE. These columns satisfy a data-auditing requirement to identify the user and date of database transactions.

Use the “CREATED” columns when you are inserting new data rows and the “CHANGED” columns when you are updating a data row. The ROW_CHANGED / CREATED_BY columns are usually populated using the system login id in use. ROW_CHANGED / CREATED_DATE is usually set to the system date of the insert or update operation.

To populate the SOURCE column, specify where you obtained the data. If you receive the data from Vendor A, and Vendor A received the data from Regulatory B, you should set the SOURCE to Vendor A. In some cases (such as for interpreted picks), data is created by an application. In this case, the source may be set to identify the application that created the data.

Identifying Rows Of Data That Are Active

Maintaining information about how a business object has changed over time is an important business requirement for all these modules. To support this, mechanisms for allowing versioning have been added to many tables.

Many tables in PPDM version 3.7 contain a column called ACTIVE_IND. The values for this column may be one of Y, N, or null. When more than one row of data (such as a spatial description or a status) has been created for a business object, use the ACTIVE_IND to indicate which row is currently active (note that in some cases, more than one row may be active simultaneously).

This provides implementers with two benefits. First, when populating EFFECTIVE_DATE and EXPIRY_DATE it will not be necessary to populate EXPIRY_DATE with a false future date to indicate that the row of data has not expired yet. Second, queries can explicitly search only for rows that are active.

If this column is used for queries, as recommended (such as "find me the currently active status for this land right"), you should implement procedures to ensure that this column is always populated as either Y or N and maintained appropriately. If the column is left blank (NULL), the query will not be consistent or reliable.

For example, you could default the value to N if the expiry date is filled in and has already happened. Make it Y if the expiry date is empty *or* if the expiry date contains a future date.

Modifying the PPDM Model

Subsetting PPDM

The PPDM data model is designed to allow users to implement portions that support their business without needing to manage modules that are not required. Good data management practices are also supported; this means that data redundancy is reduced in the Model whenever possible.

All information about Reserves will be found in the Reserves module; information about contracts is stored in the Contracts module, details about objects that are retained for long term use are stored in the Records Management module and so on. Depending on your business requirements, you can implement all or some of the modules.

In general, it is usually simplest to install the entire PPDM data model and simply restrict usage to the portions that are useful to you. Additional tables can be implemented as your business requirements expand, or as your data and processes are able to support capture in a data model. Architectural guidelines for subsetting PPDM are contained in the PPDM Architectural Principles Document. This document can be obtained from the PPDM Association or downloaded from the PPDM web site at www.ppdm.org.

Expanding PPDM

As a consequence of the PPDM Design process, which actively solicits and incorporates business requirements from Industry, many users find that the model is quite complete. However, individual implementations may find that additional columns are needed, or that some denormalization will help their performance.

The Association provides documentation about how to expand the data model to accommodate your specific requirements. This document can be obtained from the PPDM Association or downloaded from the PPDM web site at www.ppdm.org.

Feedback to PPDM

Much of the growth of the PPDM model can be attributed to Industry feedback. All implementers are requested and encouraged to provide feedback to the Association about changes they have made for implementation. Feedback can be submitted to changes@ppdm.org.

Frequently Asked Questions (FAQ)

What is a well log curve class system?

Classification systems are defined to allow well log curve classes to be grouped according to some logical system. This is done to facilitate retrieval and searches for curves of a specific type. Three possible classification systems are as follows:

1. "Value to the Customer" This classification system basically groups all curves into one of three simple classes.
   a) BASIC (or HIGH Value) - The curves of highest interest to the largest number of people. These are the curves that are generally presented on well log plots.
   b) CUSTOMER (or MEDIUM Value) - The more esoteric curves, often used by experts or those curves used directly to produce curves in the BASIC set.
   c) PRODUCER (or LOW Value) - Curves generally only of interest to the Logging company. The largest set.

   All BASIC curves are assumed to be a subset of the CUSTOMER and PRODUCER sets, and likewise, the CUSTOMER set is assumed to be a subset of the PRODUCER set. This concept was introduced by Schlumberger™ and information is available from the POSC Practical Well Log Standards (PWLS) Group for most logging companies.
2. "Hierarchical Classification by property" This is basically the Schlumberger™ OSDD hierarchical property classes adopted by PWLS. Example values are "resistivity", "deep resistivity", "gamma ray", etc. There are currently 3257 classes in this system.
3. "Oil Company specific." Each company may have their own historical classification system. Company specific classification systems tend to have many similarities, but none are identical. These systems have evolved over time and generally contain less than 100 values.

Many other classification systems are possible.

How can I store my well logging tool configuration in PPDM 3.7?

PPDM version 3.7 gives you three options for capturing well log tool information:
1. The tool type is captured in the reference table R_LOG_TOOL_TYPE. This table is referenced by the table WELL_LOG_CURVE.
2. Provide a reference to an image or document describing the tool. This reference will be stored in the RM (RECORDS MANAGEMENT) module of PPDM 3.7. In this case, you can point to the physical location where the information is stored, identify a digital file containing the information, or store the information directly in a table.
3. Reference the tool diagram on a well log image as a section of the image.

What is a well log frame and how does it work? When I look at a well log, I don't see a frame.

The term Frame has two closely related meanings depending on its context. A "Frame of Data" contains one sample of each curve associated with a specific primary index value (e.g. depth or time). Check here for more information about Frames.

How should I store my raster log image data in PPDM?

Raster images are managed in the Records Management module of PPDM 3.7. Any type of raster or other digital format may be stored in PPDM. Refer to the Table Descriptions for information about the function of each table. Briefly, this is the work flow you should follow.

First, describe the technical contents of the log or curve using the Well Log module. The actual well log could be a digital file (LIS, LAS, DLIS etc), a raster image (tiff etc) or some physical form (paper, tape etc.). If you want to store information about how and where the well log product is, use the Records Management Module.

The RM INFORMATION ITEM table describes the contents of any product in fairly general terms – usually the level of Meta data necessary for an indexing system. The RM INFO ITEM CONTENT table associates the product with the actual well log or curve. Note that one product may be associated with many logs or curves.

Information about how a product has been rendered into physical form is stored in RM PHYSICAL ITEM – here you can store details about the format, size and technical characteristics of the digital file, tape or other media. In the case of raster images, many users break the image down into components (headers, scale sections, curve sections) and provide depth calibration information with the data. These special details are captured in the RM_IMAGE_% tables.

You may store the digital data directly in your PPDM database using the table RM_FILE_CONTENT. Alternatively, you can also store raster logs in a flat file outside the database and reference its location using the RM module. The tables RM_DATA_STORE and RM_PHYS_ITEM_STORE will help you track where the product has been stored.

How do I figure out what the well log class of my log is?

The table WELL_LOG_CLASS will store this information. Note that a well log may be classified in one or more ways, depending on the needs of the users.

What is the difference between a log and a curve?

In PPDM, a log is generally considered to be the group of objects including one or more curves, a header and other related diagrams and so on. Many users are accustomed to seeing paper or raster logs; these will be comprised of one or more curves.

What is the difference between the log title and the log type?

The log title is an unformatted log name; in common usage it often includes the type of log, perhaps in combination with other information. The log type is a validated field that may be used for searches and retrievals.

How do I find out which log types created by one logging company are similar to log types created by another logging company?

The table WELL_LOG_DICT_CRV_CLS can be used to associate the various curve mnemonics used by logging contractors with curve classifications. Each curve classification may be used to classify well logs in WELL_LOG_CLS_CRV_CLS.

What is the difference between a well log class and a well log curve class? They seem very similar to me.

Since well log classifications are generally based on the types of curves found in the log, you are quite correct – there is similarity. The difference is that the curve classifications are very atomic in nature, while it is common for logs to be classified based on a combination of curve classes that are present.

How do I know what log data or curves were derived from which sources?

WELL LOG CURVE SPLICE and WELL LOG DGTZ CURVE indicate which sections of source logs were used in the creation of a new log or curve.

Why was the WELL LOG PASS table extracted and remodeled in PPDM version 3.7? How is a pass different from a run and a trip?

For definitions of these terms, refer to the definitions provided earlier in this guide. In earlier versions of PPDM, the tables were modeled on the assumption that only final log data was available – in that case, each log is actually a composite of information from more than one pass. PPDM 3.7 has modeled these tables to more closely reflect the business process, in which each pass generates one or more curves.

How are digitized logs or curves handled in the model?

Digitized logs and curves may be handled using the standards WELL_LOG% tables. Details about the digitization of the data are stored in WELL_LOG_DGTZ_CURVE. If desired, actual digitized values may be tracked in WELL_LOG_CURVE_VALUE.

Can I store the entire contents of a digital log and then recreate the log later from the database? Will any information be lost?

The model was designed to allow you to do just that. Be aware, however, that this may be very space intensive.

What kind of images can I capture? Can I only capture well log images, or could I also capture other types of images such as well or tool diagrams?

Any type of image may be described in the RM_IMAGE% tables, including well logs and curves.

Appendix A: Sample Queries

These sample queries have been developed using a subset of the requirements defined in the Business Requirements Document. Note that there are many ways to address the questions posed here, but we have tried to provide useful examples that illustrate the use of the data model. The PPDM Association does not provide any guarantee that these queries will satisfy your business requirements; they are for illustration only.

- **Versioning over time:** Many aspects of the oil and gas business have a strong time component. Users require information about how a business object was configured in the past, what it looks like now, and what it is expected to look like in the future (i.e., if a project is not active now, when was it in the past). If your queries need to address the situation as it is now, use the ACTIVE_IND you will find in many versioned tables. Using this flag helps ensure that you do not return data that is out of date.

- **Effective and Expiry dates:** Reserves volumes are expected to change over time. To manage reserve reporting cycles, the reserves data is usually updated only within the current reserves period. At the end of this period the reserve volumes are considered to be frozen. Subsequent changes to these volumes then occur in a subsequent reserves period. To manage the concept of a reserves reporting period, most reserves tables also use a effective date and expiry date. To ensure that a query returns data for a specific period of time, add selection criteria to the effect that the date of interest is greater or equal to the effective date of the data, and less than or equal to the expiry date of the data.

- **Units of Measure:** Several examples have been provided to show how units of measure should be queried in PPDM. As these queries are nearly always handled the same way, this guide does not show the method every time it is needed; the authors felt that this would create confusion and obscure the main intent of the query.

What density logs do I have in the Garrison field?

```
SELECT      W.UWI, TOP_DEPTH, BASE_DEPTH
FROM        WELL W, WELL_LOG WL, WELL_LOG_CLASS WLC
WHERE       W.UWI=WL.UWI AND WL.UWI=WLC.UWI
  AND       WL.WELL_LOG_ID=WLC.WELL_LOG_ID
  AND       WL.SOURCE=WLC.SOURCE
  AND       W.ASSIGNED_FIELD = 'GARRISON'
  AND       WLC.WELL_LOG_CLASS = 'DENSITY'
```

What logs do I have in this field below 11,000 feet?

```
SELECT      W.UWI,WLC.WELL_LOG_CLASS,TOP_DEPTH,BASE_DEPTH
FROM        WELL W,WELL_LOG WL,WELL_LOG_CLASS WLC
```

```
WHERE       W.UWI=WL.UWI AND WL.UWI=WLC.UWI
  AND       WL.WELL_LOG_ID=WLC.WELL_LOG_ID
  AND       WL.SOURCE=WLC.SOURCE AND W.ASSIGNED_FIELD = 'GARRISON'
  AND       ((BASE_DEPTH > 11000 AND BASE_DEPTH_OUOM = 'FEET')
   OR        (BASE_DEPTH > 3330 AND BASE_DEPTH_OUOM = 'METRES'))
```

How many logs do I have that penetrate the Arbuckle formation?

```
SELECT      W.UWI,WL.WELL_LOG_ID,WELL_LOG_CLASS,
            TOP_DEPTH,BASE_DEPTH,PICK_DEPTH
FROM        WELL W,STRAT_WELL_SECTION SWS,WELL_LOG WL,WELL_LOG_CLASS
WLC
WHERE       W.UWI=WL.UWI AND W.UWI=SWS.UWI AND SWS.UWI=WL.UWI
  AND       W.UWI=WLC.UWI AND WL.UWI=WLC.UWI AND SWS.UWI=WLC.UWI
  AND       WL.WELL_LOG_ID=WLC.WELL_LOG_ID
  AND       WL.SOURCE=WLC.WELL_LOG_SOURCE
  AND       SWS.STRAT_NAME_SET_ID = 'IPL'
  AND       SWS.STRAT_UNIT_ID = 'ARBUCKLE'
  AND       PICK_DEPTH BETWEEN TOP_DEPTH AND BASE_DEPTH
```

Are there any gaps in this well log?

```
SELECT      WELL_LOG_ID,WELL_LOG_SOURCE,TOP_DEPTH,BASE_DEPTH
FROM        WELL_LOG_CURVE_FRAME
WHERE       UWI = '100100107010W600' AND GAPS_IND = 'Y'
```

Now that I have found the log I am interested in, how do I find the actual data?

```
SELECT      CURVE_ID,SAMPLE_ID,INDEX_VALUE,INDEX_VALUE_UOM,
            MEASURED_VALUE,MEASURED_VALUE_UOM
FROM        WELL_LOG_CURVE_VALUE
WHERE       UWI = '100100107010W600' AND INDEX_TYPE = 'DEPTH'
ORDER BY    CURVE_ID,SAMPLE_ID,MEASURED_VALUE
```

Please note that there are two other tables that this data could be stored in: RM_FILE_CONTENT & RM_IMAGE_*

Which is the most recent log in the area?

```
SELECT      W.UWI,MAX(WLC.EFFECTIVE_DATE) MOST_RECENT,WLC.CURVE_ID
FROM        WELL W, WELL_AREA WA, WELL_LOG_CURVE WLC
WHERE       W.UWI=WA.UWI AND AREA_ID = 'Western Can'
  AND       AREA_TYPE = 'BASIN' AND W.UWI=WLC.UWI
GROUP BY    W.UWI,WLC.CURVE_ID
```

For wells I have identified, which have logs and which are depth calibrated?

```
SELECT      W.UWI,TOP_DEPTH,BASE_DEPTH,WELL_LOG_CLASS
FROM        WELL W,RM_IMAGE_SECT RIS
```

```
WHERE       W.UWI=RIS.PHYSICAL_ITEM_ID
  AND       CALIBRATE_METHOD = 'DEPTH'
```

What logs that I have include a directional survey?

```
SELECT      W.UWI,DIR_SURVEY_CLASS,WS.TOP_DEPTH,
            WS.BASE_DEPTH,WELL_LOG_ID,WL.TOP_DEPTH,WL.BASE_DEPTH
FROM        WELL W,WELL_DIR_SRVY WS,WELL_LOG WL
WHERE       W.UWI=WL.UWI AND WL.UWI=WS.UWI AND WS.UWI=W.UWI
  AND       ((WL.TOP_DEPTH BETWEEN WS.TOP_DEPTH AND WS.BASE_DEPTH)
   OR        (WL.BASE_DEPTH BETWEEN WS.TOP_DEPTH AND WS.BASE_DEPTH))
```

Show me who is entitled to have access to this well log.

```
SELECT      ESB.BUSINESS_ASSOCIATE,ACCESS_TYPE
FROM        ENT_COMPONENT EC,ENT_GROUP EG,ENT_SECURITY_BA ESB
WHERE       EG.ENTITLEMENT_ID=EC.ENTITLEMENT_ID AND
            EG.SECURITY_GROUP_ID=ESB.SECURITY_GROUP_ID
  AND       EC.UWI = '100100107010W600' AND EC.WELL_LOG_ID = '20'
```

When is this well log going to be releasable (made public).

```
SELECT      EC.UWI,E.EFFECTIVE_DATE,PRIMARY_TERM,PRIMARY_TERM_OUOM
FROM        ENT_COMPONENT EC,ENTITLEMENT E
WHERE       E.ENTITLEMENT_ID=EC.ENTITLEMENT_ID
  AND       EC.UWI = '100100107010W600' AND EC.WELL_LOG_ID = '20'
```

Show me which logs did not make it to the TD of the well?

```
SELECT      W.UWI,DIR_SURVEY_CLASS,WS.TOP_DEPTH,
            WS.BASE_DEPTH,WELL_LOG_ID,WL.TOP_DEPTH,WL.BASE_DEPTH
FROM        WELL W,WELL_DIR_SRVY WS,WELL_LOG WL
WHERE       W.UWI=WL.UWI AND WL.UWI=WS.UWI AND WS.UWI=W.UWI
  AND       ((WL.TOP_DEPTH BETWEEN WS.TOP_DEPTH AND WS.BASE_DEPTH)
   OR       (WL.BASE_DEPTH BETWEEN WS.TOP_DEPTH AND WS.BASE_DEPTH))
```

Can I have different versions of the directional survey for a well and if I do, how do I know which one I used for a TVD log?

```
SELECT      WS1.UWI,WS1.SURVEY_ID
FROM        WELL_DIR_SRVY WS1,WELL_DIR_SRVY WS2
WHERE       WS1.UWI=WS2.UWI AND WS2.DIR_SURVEY_CLASS =
            WS1.DIR_SURVEY_CLASS AND  WS1.TOP_DEPTH=WS2.TOP_DEPTH
  AND       WS1.BASE_DEPTH=WS2.BASE_DEPTH
  AND       WS1.SURVEY_TYPE = WS2.SURVEY_TYPE AND WS1.ACTIVE_IND = 'Y'
```

Which logs have been datum corrected?

```
SELECT      WL.UWI,WL.CURVE_ID,WL.DIGITAL_CURVE_ID,
            TOP_DEPTH,BASE_DEPTH,EFFECTIVE_DATE,CURVE_QUALITY
FROM        WELL_LOG_DGTZ_CURVE WL
WHERE       DEPTH_CORRECTION_METHOD = 'DATUM'
```