PPDM Association

Well Operations Reference Guide

Last updated for PPDM 3.8
Version 1.0

CAUTION: Table names may be out of date in this document, refer to the data model documentation to be current.

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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 Operations Data Module in PPDM 3.8. 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 PPDM.

This reference guide contains the following sections:

- Introduction

  Provides an executive overview of the PPDM Model as it pertains to PPDM3.8 Metadata module.

- Business Process Overview

  Summarizes Metadata and provides examples of related business processes.

- Integration

  Discusses how Metadata is integrated with the other PPDM Business Modules and provides information about related references guides.

- Model Overview

  Includes data diagrams.

- Tables and Columns – Metadata

- Identifies the data model tables for the Metadata 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 Metadata Module.

- Appendix A – Sample Queries

  Provides example queries with the appropriate SQL scripts that illustrate uses of the Metadata model.

- Appendix B – Changes to the Model

  Identifies the changes in the Metadata Module from the latest version to the newest release version of the PPDM model.

Introduction

Business Process Overview

Purpose

Key Business Processes

Further Reading

"Natural Gas: From Wellhead to Burner Tip: Extraction." NaturalGas.org. 1994. Natural Gas Supply Association. 9 Nov. 2006. <http://www.naturalgas.org/naturalgas/extraction.asp>

Schlumberger Oilfield Glossary. c2006. Schlumberger Limited. 9 Nov. 2006. <http://www.glossary.oilfield.slb.com/>

Model Overview

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:

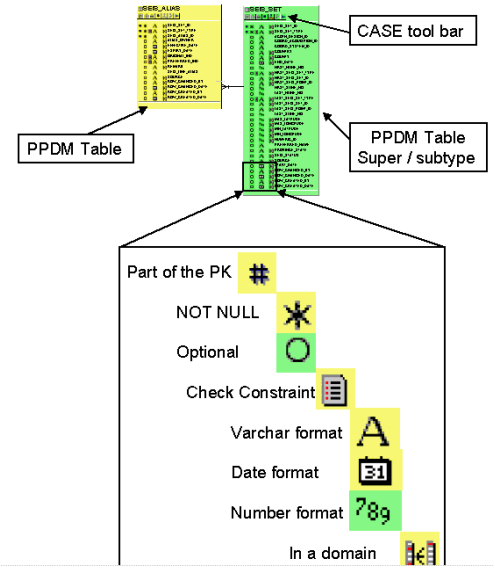

Figure 1: *This illustration shows the functions of each icon used in the data diagrams provided with PPDM version 3.8.*

The data diagrams for the Well Operations 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 Operations

The following tables exist in the Metadata module of PPDM version 3.8. Each table is described in the following section; you can jump to a table description by clicking on the hyperlinked table name below. Note that for detailed content descriptions for each table, you should refer to the PPDM version 3.6 table documentation.

The Well, Well Version, and Well XREF tables

In the Well Operations Module, all the information is referenced to a particular well. The primary key is the Unique Well Identifier (UWI). The UWI is therefore part of the primary key in every related table throughout this module. WELL_VERSION is an almost identical table, with the addition of SOURCE to the primary key. This allows for storage of multiple versions of the same information about a well, and the promotion of one set of information to the WELL table for routine use.

WELL

This table contains general and header information about a well. A well is an actual or proposed hole in the ground, designed to exchange fluids between a subsurface reservoir and the surface (or another reservoir) or to enable the detection and measurement of rock properties. A wellbore is a cylindrical hole created by a drill.[1] A well may consist of zero, one, or more wellbores; their relationships are described in PARENT_UWI and the WELL_XREF table. Information from other well tables (e.g. key dates and depths) may be included (denormalized) for convenience.

Header information to be stored in the WELL table include SPUD_DATE, RIG_ON_SITE_DATE, RIG_RELEASE_DATE, and KB_ELEV.

Other general information can be recorded in the following columns:

[1] In the PPDM model, the term “well” is used to mean either “well” or “wellbore”, depending on context.

- The DEPTH_DATUM column describes the reference assigned a measured depth of 0 – the level from which other depths are reported.[2] It is often the kelly bushing or derrick floor.

- DEPTH_DATUM_ELEV records the elevation (e.g., height above mean sea level) of the depth datum. Subsurface elevations may then be computed as DEPTH_DATUM_ELEV – MEASURED_DEPTH, providing that the measured depth is "true vertical".

- DRILL_TD is the total depth reported by the driller (or operator). It is the length from the datum (at the surface) to the bottom of the hole, measured along the wellbore. This total depth may vary somewhat from the total depth measured by logging tools or by other means, especially in a very deep well.

- FINAL_TD may be redundant with DRILL_TD, but this column can also be used to capture the preferred value for total depth, which may disagree with the driller's depth.

- GROUND_ELEV_TYPE describes the type of datum (ex. barge deck, platform floor, Kelly bushing) for the ground elevation. Allowable values are stored in the reference table R_WELL_DATUM_TYPE.

- INITIAL_CLASS is the assigned "class" of the well, such as New Pool Wildcat, indicating why the well was drilled.

- LEASE_NAME and LEASE_NUM allow connections to the PPDM Land Module, although no foreign key is assigned in PPDM 3.8. A well is usually part of a lease or other type of permit to drill and operate. provide an unvalidated link to the lease under which the well is being drilled and operated, and are used to support older PPDM implementations. Use the LAND_RIGHT_% tables to provide validated links between a well and its corresponding surface or mineral rights.

- LOG_TD is the maximum depth achieved by the wireline logging tools. It provides another estimate of the total depth of the well, separate from the calculation made by the driller. However, in some wells, logs are not run to the bottom (e.g., hole collapse), so LOG_TD might be a much smaller value than DRILL_TD.

- MAX_TVD is the total depth of the well as measured vertically from the datum. It should be computed from directional surveys, if available. Otherwise, it should be left null.

- NET_PAY is the cumulative thickness of productive reservoir in the well. Normally, this value refers to only the producing zone in the well, although it

[2] In some cases, some depth measurements use a separate datum. These cases have been anticipated in PPDM and extra datum columns have been added to tables. For an example, see the table WELL_LOG_TRIP.

is possible to have multiple pay zones. Detailed information is captured in the WELL_PAYZONE table, as the WELL table provides only a summary.

- The OLDEST_STRAT_% columns record the oldest unit (formation) encountered in the well. In faulted or overturned strata, the oldest unit is not necessarily found at the bottom of the well.

- OPERATOR is the name of the business associate currently holding the permit to drill and responsible for reporting the drilling activity to the regulatory agency. The operator may be acting on behalf of other partners in the well. Operators may change over the life of a well – the WELL_BA_SERVICE table should be used to track the complete history.

- PARENT_RELATIONSHIP_TYPE was historically used to describe the relationships of wellbores in the same well or if a wellbore is related to another in the same well (e.g., sidetrack). This information is necessary to reconstruct the geometry of a well with multiple holes. This information should now be tracked in the WELL_XREF table (this column remains in the model to support older data)

- PRIMARY_SOURCE is the link to the main source of the data in the WELL_VERSION table.

- PROFILE_TYPE is a general description of the well, such as vertical or directional.

- The SOURCE describes the supplier of the data, while the SOURCE_DOCUMENT describes the original data source, if known. For example, for a particular well, the SOURCE could be the data vendor who collected and delivered the data to a client, while the SOURCE_DOCUMENT could be a well report submitted to the government.

- TD_STRAT_UNIT_ID identifies the deepest formation encountered in the well.

- WELL_GOVERNMENT_ID may be any string describing the well, as assigned by the regulatory agency. It is not used in the primary key for this table, but it may be identical to the UWI in some jurisdictions. Use the WELL_ALIAS table to track all different well descriptors.

- WELL_NUM may be any string describing the well, as assigned by the operator or by the owner of the database. It is not used in the primary key for this table, but may be useful to simplify or shorten the well designations on maps and printed lists. Use the WELL_ALIAS table to track all different well descriptors.

- WELL_NUMERIC_ID is a unique number for use in spatial queries. Note that it is not the same data type as WELL.UWI. Use the WELL_ALIAS table to track all different well descriptors.

Some columns in the WELL table contain information that should also be recorded in other tables. Data are sometimes duplicated in the WELL table to improve database or application performance, and in some circumstances, is duplicated through the receipt of data from a vendor. The data administrator should decide how to achieve acceptable data quality if the same information is stored in two places. Uniformity could be achieved by having quality checks on loading, or by using database triggers to populate one column from the other.

- The source for SURFACE_LATITUDE, SURFACE_LONGITUDE, BOTTOM_HOLE_LATITUDE and BOTTOM_HOLE_LONGITUDE are the WELL_NODE.LATITUDE and WELL_NODE.LONGITUDE columns (bottom or surface position indicated in the WELL_NODE.NODE_POSITION column). Including these coordinates in the WELL table may substantially improve the performance of many applications.

- The source for COMPLETION_DATE is WELL_COMPLETION.COMPLETION_DATE.

- The source for CURRENT_STATUS is the WELL_STATUS.STATUS column corresponding to the latest STATUS_DATE.

- The source for LOG_TD is WELL_LOG_TRIP.BASE_DEPTH. This information is difficult to populate programmatically because each log trip may have a different depth.

- The source for MAX_TVD is WELL_DIR_SRVY_STATION.STATION_TVD. This information is difficult to populate programmatically because there may be multiple surveys, and none may have reached total depth.

- The column NET_PAY supports older implementations. Use the WELL_PAYZONE table to track the pay zones of a well.

- The source for OLDEST_STRAT_UNIT_ID is STRAT_WELL_SECTION.STRAT_UNIT_ID, where CERTIFIED_IND = Y and the oldest unit is determined from the STRAT_UNIT_AGE table. (The STRAT_NAME_SET_NAME must be specified).

- The source for PLUGBACK_DEPTH is the WELL_PLUGBACK.TOP_DEPTH column corresponding to the latest PLUGBACK_DATE and/or the selected PLUG_TYPE.

- The source for TD_STRAT_UNIT_ID is the STRAT_WELL_SECTION.STRAT_UNIT_ID found at maximum depth, where CERTIFIED_IND = Y. (The STRAT_NAME_SET_NAME must be specified).

- The source for WHIPSTOCK_DEPTH is WELL_ACTIVITY.BASE_DEPTH, where the ACTIVITY_TYPE is "whipstock".

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WELL_VERSION

The WELL_VERSION table is a duplicate of the WELL table, except for the addition of SOURCE in the primary key to accommodate versioning. Different sources may report different values for the same data item, because of varying collection methods or source documents, age of the report, etc.

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WELL_XREF

The WELL CROSS REFERENCE table supports complex relationships between wells. For example, it can provide a link between a planned well and the actual well that was drilled, or can show more complex relationships between a parent well and wellbores.

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Well Drill Operations

A Well Drill Period refers to any period that is used to report well drilling operations, and is usually based on regulatory reporting requirements. Internationally, there may be 1, 2 or 3 periods each 24 hours. In some jurisdictions, reporting may occur for more than one period, such as for an 8 hour tour shift and a 24 daily summary. Tables in this group contain information that is usually reported once during a well tour or some other time period. Information related to billing and payroll (rig details, operator information, etc), safety meetings, and operations (mud types, circulating system pressures, etc.) are tracked. Data relating to each removal or insertion of the drill string, as well as cumulative inventories of tubing in the wellbore are also stored here.

WELL_DRILL_REPORT

Well drilling reports are often prepared and provided as summaries that cover one or more tours (shifts) at a particular well. Data in this table record the number of periods, and the time interval covered by a particular report. By comparing the date and time ranges in WELL_DRILL_PERIOD and WELL_DRILL_REPORT, the specific tours covered by a report can be determined.

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WELL_DRILL_PERIOD

Use this table to report information that is usually recorded once per drill period – this information provides a summary of the equipment in use, and work done during a drill period.

The START_DATE and START_TIME, and END_DATE and END_TIME of the drill period are recorded.

The KB_DOWN_LENGTH measures the length of kelly below the kelly bushing measuring point – this measurement is required in order to calculate Total Depth.

The MUD_SYSTEM_TYPE and MUD_TYPE tables describe the mud system in use, while the CIRC_PRESSURE_% columns describe the maximum and minimum circulating pressures reached during the drilling period, as well as the pressure at report time. The CASING_PRESS_MAX column reports the maximum pressure that can be held at the surface in a kick situation (this depends on the drilling fluid density, the depth of the casing shoe, and on the surface equipment).

The DRILL_PIPE_% columns record information about the lengths of drill pipe inventoried and the length of drill pipe in the hole; the TOT_DRILL_TOOL_% columns record the total length and weight of all drilling tools in the well. The weight of the Bottom-Hole Assembly (BHA) is recorded in BHA_WEIGHT. . These data are recorded at the period report time (usually the beginning or end of the drill period). The HOOKLOAD_MAX describes the maximum load carried by the hook during the drill period, while the HOLE_DRAG measures the force required to pull the drill string out of the hole. The HOLE_FILL_LENGTH describes the amount of material that has caved or settled in when the drillstring has been removed.

The DRILL_STRING_TORQUE records the amount (usually at the reporting time) of torque required to turn the drill string.

RIG_FUEL and BOILER fuel columns record the amount of fuel in the tanks at the reporting time, while the amount of fuel used by the operator during a drill period is recorded in OPERATOR_FUEL.

Safety days are recorded in the CUM_CREW_SAFETY_DAYS and CUM_RIG_SAFETY_DAYS columns; the topics of safety meetings held during the drilling period are reported in SAFETY_MEETING_TOPIC, while the OPERATOR_REP_% columns record information about the business associate representing the operator during the drill period.

The REPORTED_% columns allow an exact copy (including errors) of the header information written on forms to be entered into PPDM (in some circumstances, it is required that data be stored exactly as entered by field personnel).

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WELL_DRILL_WEATHER

Intended for both land and marine drilling, this table captures weather, road, or oceanic conditions occurring during a well drilling period. For any period, any number of readings may be captured.

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WELL_DRILL_STATISTIC

Use this table to capture drill period statistics or metrics that are not defined elsewhere. A period can refer to any length of time, including shift lengths, days, weeks, months, years.

The reference tables R_DRILL_STAT_TYPE and R_DRILL_STAT_CODE must be populated before the WELL_DRILL_STATISTIC table is completed.

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WELL_DRILL_REMARK

This table contains additional unformatted narrative information pertaining to well operations that is not covered by the detail tables.

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Well Drill Marine Operations

Although much information collected during marine drilling is also collected in land drilling, some specialized data exist. Data concerning vessels serving the well operations are recorded in the WELL_DRILL._PERIOD_VESSEL table. Tables in the Support Facilities Module are also used to track marine drilling operations.

WELL_DRILL_PERIOD_VESSEL

This table describes information about the deployment or configuration of vessels used during a reporting period.

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Well Activity & Well Activity Components

These tables provide a breakdown of all activity taking place during a well drill period. Tables track the regular operations taking place—for example drilling, repairing or servicing the rig, coring, taking logs, and holding safety meetings, and also track unscheduled events that might occur (for example, lost circulation, blowouts, casing failure, and fishing operations). The WELL_ACTIVITY table

tracks all events—an event lasting any length of time can be recorded,[3] and all time intervals within a period should be accounted for. Codes and restricted vocabulary describing events are accommodated by the WELL_ACTIVITY, WELL_ACTIVITY_SET, and WELL_ACTIVITY_TYPE_% tables.

The WELL_ACTIVITY_COMPONENT table tracks objects (logs, cores, samples), equipment, events within, and costs associated with an activity, while the WELL_SHOW table tracks the appearance of samples containing hydrocarbons. The WELL_TUBULAR and WELL_CEMENT tables track data concerning tubing, casing, lining, and cement inserted in the well. The WELL_STATUS table tracks long-term well status (for example, drilling, completed, producing, abandoned).

WELL_ACTIVITY

Use this table to record the events that occur during the well operations phase. An activity is assigned an ACTIVITY_OBS_NO, and can be linked to the date and time of occurrence, the PERIOD_ID, and the depth of the well. The table can accommodate both recurrent events and unique events. By considering all information in this table pertaining to one well, it should be possible to reconstruct a complete schedule of all events occurring during the drilling of that well.

Well activities are sometimes known as Events, Statuses, Conditions, and Occurrences.

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WELL_ACTIVITY_COMPONENT

Use this table to keep track of objects created during an activity (logs, cores, tests), equipment used in an activity, events associated with an activity, or costs associated with an activity. With the COMPONENT_OBS_NO in the primary key, the table links data describing a well activity to data stored in other PPDM modules.

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WELL_ACTIVITY_SET

This table describes sets of codes or restricted vocabulary that may used to describe well activities. A set of activity codes may be defined by a professional body such as the CAODC, by a regulatory agency, by a service company, or by an operator, and therefore, more than one set of codes may be used during a single drilling operation. This table links the set (identified in the column ACTIVITY_SET_ID) to the creator of the codes. Codes within a set are not defined here – they are described in the WELL_ACTIVITY_TYPE table.

[3] The CAODC breaks down activity reporting into 15-minute blocks of time.

Sample WELL_ACTIVITY_SET entries

ACTIVITY SET ID	*ACTIVITY SET TYPE*	*OWNER BA ID*	*PREFERRED IND*	*SOURCE*	*SOURCE DOCUMENT*
E&P	CORPORATE	COMPANY X	Y	COMPANY X	DRILLING GUIDE
FINANCE	CORPORATE	COMPANY X	N	COMPANY X	ACCOUNTING GUIDELINES
STATE 1 REG BODY	REGULATORY	STATE 1	N	Y	DIRECTIVE 7
STATE 2 REG BODY	REGULATORY	STATE 2	N	N	DRILLING FORM W-02

Note

- Primary key: ACTIVITY_SET_ID

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WELL_ACTIVITY_TYPE

This table defines valid codes and/or terminology, describing well activities, belonging to sets described in the WELL_ACTIVITY_SET table.

For example, within a set XXX, valid activities might include rigging up, drilling ahead, setting casing, waiting on cement, fishing, sidetracking, coring, logging, testing, plugging, and completing. In each row, XXX would be entered as the primary key ACTIVITY_SET_ID; the codes or terms describing the activities would be entered, one per row, under the primary key ACTIVITY_TYPE.

When activities have been assigned both a code a standardized name, the name should be recorded as the ACTIVITY_TYPE, and the corresponding code should be entered in the WELL_ACTIVITY_TYPE_ALIAS table.

Sample WELL_ACTIVITY_TYPE entries

ACTIVITY SET ID	*ACTIVITY TYPE*	*REGULATORY REPORT IND*	*SOURCE*
E&P	DRILLING	N	COMPANY X
E&P	REPAIR RIG	N	COMPANY X
E&P	CORING	N	COMPANY X
STATE 1 REG BODY	REPAIRS	Y	STATE 1
STATE 1 REG BODY	CORE	Y	STATE 1
STATE 1 REG BODY	SAFETY MEETING	Y	STATE 1

Note

- Primary key: ACTIVITY_SET_ID, ACTIVITY_TYPE.

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WELL_ACTIVITY_TYPE_ALIAS

This table contains names and identifiers under which a well activity might otherwise be known.

Sample WELL_ACTIVITY_TYPE_ALIAS entries

ACTIVITY SET ID	*ACTIVITY TYPE*	*ALIAS OBS NO*	*ALIAS CODE*	*ALIAS OWNER BA ID*	*ALIAS TYPE*	*FULL NAME*	*PREFERRED IND*
E&P	DRILLING	1	DRILLING	COMPANY X	CORP CODE	Actual drilling in progress	N
E&P	REPAIR RIG	1	REPAIR RIG	COMPANY X	CORP CODE	Repairing the rig	N
E&P	CORING	1	CORING	COMPANY X	CORP CODE	Coring Operation	N
E&P	DRILLING	2	EPWA01	COMPANY X	CORP CODE	Actual drilling in progress	Y
E&P	REPAIR RIG	2	EPWA02	COMPANY X	CORP CODE	Repairing the rig	Y
E&P	CORING	2	EPWA03	COMPANY X	CORP CODE	Coring Operation	Y
STATE 1 REG BODY	REPAIRS	1	REPAIRS	REPAIRS	REGULATORY	Any equipment repair work	N
A STATE 1 REG BODY	CORE	1	CORE	STATE 1	REGULATORY	Coring	N
A STATE 1 REG BODY	SAFETY MEETING	1	SAFETY MEETING	STATE 1	REGULATORY	Safety meeting held	N
STATE 1 REG BODY	REPAIRS	2	RPS	REPAIRS	REGULATORY	Any equipment repair work	Y
A STATE 1 REG BODY	CORE	2	COR	STATE 1	REGULATORY	Coring	Y
A STATE 1 REG BODY	SAFETY MEETING	2	SAF	STATE 1	REGULATORY	Safety meeting held	Y

Notes

- The PPDM Association recommends that each entry in the WELL_ACTIVITY_TYPE table is also represented in the ALIAS table.

- Primary key: ACTIVITY_SET_ID, ACTIVITY_TYPE, ALIAS_OBS_NO.

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WELL_ACTIVITY_TYPE_EQUIV

As different organizations or regulatory agencies may name or group activities differently, the WELL_ACTIVITY_TYPE_EQUIVALENCE table gives you an opportunity to state equivalencies between activities that are defined in different WELL_ACTIVITY_SETs.

Sample WELL_ACTIVITY_TYPE_EQUIV entries

ACTIVITY SET ID	*ACTIVITY TYPE*	*ACTIVITY SET ID2*	*ACTIVITY TYPE2*	*EQUIV OBS NO*	*EQUIV OWNER BA ID*	*EQUIV TYPE*
E&P	REPAIR RIG	STATE 1 REG BODY	REPAIRS	1	COMPANY X	SUBTYPE
E&P	CORING	A STATE 1 REG BODY	CORE	2	COMPANY X	EQUIVALENT

Note

- Primary key: ACTIVITY_SET_ID, ACTIVITY_TYPE, ACTIVITY_SET_ID2, ACTIVITY_TYPE2, EQUIV OBS NO.

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WELL_TUBULAR

The Well Tubular table contains information on the tubulars inserted into the well. Tubular is a general term for any kind of oilfield pipe, including tubing, casing and liners. A tubing string is a continuous length of pipe used to connect the producing interval in the well to the flowline at the surface, for the purpose of carrying produced fluids.

A casing string is a continuous length of pipe used to protect the walls of the well and to assist in isolating intervals when completing the well. Casing strings are sometimes classified as surface, intermediate, and production – surface strings isolate formations and anchor equipment and other casing; intermediate strings isolate formations; production strings isolate the producing formation and house completion equipment. Liner is casing that does not extend to surface, and can be used to prevent sand from entering the well bore. A well may have one or several tubular strings of different types, diameters, properties, and purposes.[4]

[4] Because drill pipe is an integral part of the drill string and is not permanently installed, details of its use are not recorded in WELL_TUBULAR, but instead, can be found in the WELL_DRILL_PERIOD table.

The table identifies each tubular string used in a single drilling phase of the well. Each is assigned a TUBING_OBS_NO. The table also defines the length and depth of the tubing string, specifications (diameters, steel grade, weight, density, strength), and other information about the operations of installation and removal of the pipe. Using information stored in this table, it should be possible to construct a complete diagram of all tubing installed in the well.

The TOP_STRAT_UNIT_ID and BASE_STRAT_UNIT_ID columns are intended to capture the formations as reported on the source document (they must be defined with names from the same STRAT_NAME_SET). If values are not available from the source, we recommend these columns be left null. Do not copy values from STRAT_WELL_SECTION, as this would be too difficult to maintain.

Several columns use terms defined in reference tables. There is not yet ~~an agreed~~ a complete standard set of reference values, but the following values illustrate the intended meanings:

- TUBING_TYPE: general categories; e.g., casing, liner, production tubing
- COLLAR_TYPE: a coupling to join two pipes, e.g., drill collar, combination collar
- LINER_TYPE: drilling, slotted, gravel pack
- CHECK tubing type/liner type – don't fit with sample data

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WELL_CEMENT

This table describes the cementing operations performed on a well, usually with the purpose of securing and supporting a casing string, or restricting fluid movement between formations.

WELL_STATUS

The Well Status table contains an account of the status of the wellbore during all phases of its existence. With each change of status of a well, a new row would be entered in the table -- the row would link the status to the date it changed and the depth of the well at that time. In order to ensure uniqueness of the record, the primary keys include a STATUS_ID (a number, or other identifier that would be created and assigned to the row).

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Well Drill Safety

Records concerning drilling crews, and safety during the drilling operations, are collected. During each drilling tour, the rig and the site are inspected, and

reported. Checks may be conducted by both operator and contractor representatives, or by the contractor's representative alone.

WELL_DRILL_PERIOD_CREW

Use this table to link information about a crew or crew members to a particular drilling period; using this table, the history of crew members may therefore be tracked. Either an individual or a company may be considered a crew member, and a row of data can refer either to an entire crew or to an individual member of the crew.

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WELL_DRILL_CHECK_SET

Use this table to define sets of drill checks mandated by an operator company, by a regulatory agency, or in contract specifications. Each set consists of one or more checks which are described in WELL_DRILL_CHECK_TYPE.

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WELL_DRILL_CHECK_TYPE

Use this table to describe every check that is in a WELL_DRILL_CHECK_SET. Types of checks that may be included are a daily walk around inspection, a check that H_2S signs are posted, a check that BOP (blow-out preventer) drills have been performed, or a check that a visual inspection has occurred.

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WELL_DRILL_CHECK

In this table, details about the checks performed during a particular drilling operation are recorded. This section is important both to confirm that these inspections have been conducted, and to provide a record of the inspection, in compliance with government regulations and industry practice.

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Well Drill Activity

Data specific to mud and air drilling systems are collected in these tables (air drilling is rotary drilling that uses compressed air instead of a circulating mud system.). For mud drilling systems, tables link dates and drilling intervals to mud types and weights (the heavier, or more dense, the mud, the greater the pressure it

exerts). Similarly, for air drilling systems, dates and drilling intervals are linked to pressures and compressor rates. Mud weights (and water influx rates in air systems) are used to determine hydrostatic pressures – information about pressures is important, because low pressures can cause kicks in drilling, and high pressures can cause cracks in formations.

WELL_AIR_DRILL

This table contains information about the number and volume of compressors used in air drilling. Included in the primary key is the AIR_DRILL_OBS_NO.

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WELL_AIR_DRILL_INTERVAL

The Air Drilling Interval table links depth intervals to air drilling data. Compressor rate measurements, pressure gauge readouts, and water influx data can be recorded. The table also tracks the type of air/gas used in the system. Included in the primary key are the DEPTH_OBS_NO (assigned to identify a depth interval), and the AIR_DRILL_OBS_NO (assigned to all air drilling records).

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WELL_DRILL_MUD_INTRVL

The Drilling Mud/Media Interval provides a summary of the conditions in which a mud circulating system was used, linked to both the MEDIA_TYPE (mud type) and to a depth interval (identified by the DEPTH_OBS_NO).

Details including CASING_DEPTH, MAX_MUD_WEIGHT, the depth at which the maximum mud weight was used (MAX_WEIGHT_DEPTH), and the starting and ending depths corresponding to a particular mud type (MUD_START_DEPTH, MUD_END_DEPTH) are recorded..

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WELL_DRILL_MUD_WEIGHT

The Drilling Mud/Media Weight table contains information pertaining to the density (commonly called the weight) of the drilling media. Specific mud weights are linked to the depths at which they were used. Included in the primary key are the DEPTH_OBS_NO and the MEDIA_OBS_NO (identifying an observation of the media weight).

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Well Drill Equipment

The tables in this grouping record the physical characteristics of drilling equipment, and track equipment installed, used and inventoried during drilling operations.

Equipment is transported to the drilling site and either remains there for a period of time or is installed permanently in the well. Such equipment may include pipes, rig components, analysis tools, etc. Equipment is inventoried, often once each drilling tour. In addition to quantities, inventory details may include descriptions and measurements, condition reports, and, for equipment permanently installed in the wellbore, location (or depth) details.

Data about equipment serve many purposes. For example, an inventory of tubing at the well site indicates to the operators how much drilling can be performed; information about pumps that circulate mud is used in calculating pressure and volume data.

Details about shakers and sieves used in the drilling process provide information about the diameter of cuttings. Cuttings are analyzed for their composition and hydrocarbon content and can be saved for future analysis. When analyzed, information about the subsurface and its hydrocarbon content is revealed, and thus the depth intervals from which the cuttings were taken must be recorded, and the labs to which they are sent must be tracked.

WELL_DRILL_EQUIPMENT

This table tracks equipment that is used on a wellsite, but is not permanently installed. Dates and times the equipment was on the wellsite, the operator, and when applicable, its parent equipment, are among the data recorded. In order to support easy query and retrieval, any equipment and associate inventory items can be reported in this table. EQUIPMENT_ID and EQUIPMENT_OBS_NO are included in the primary key.

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WELL_EQUIPMENT

This table enumerates the equipment permanently installed at the well. The depth at which the equipment can be found, its sequential location (from the top to the well bottom), its installation (and, when necessary, its removal) date can be tracked. EQUIPMENT_ID and EQUIPMENT_OBS_NO are included in the primary key.

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WELL_DRILL_PERIOD_EQUIP

This table is used to link equipment used temporarily on a well site (for example, boilers and pumps) to the time period in which it was used. Operating conditions

and metrics relating to equipment use are recorded. Both PERIOD_ID and EQUIPMENT_ID are included in the primary key.

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WELL_DRILL_PERIOD_INV

This table records the amounts of materials (both equipment and mud additives) inventoried on-site, during a particular reporting period (specified in PERIOD_ID). Materials physically located in the wellbore are not tracked in this table – instead, they are reported in the WELL_TUBULAR and WELL_EQUIPMENT tables. Information in this table can be used to track amounts on hand, amounts ordered, etc.

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WELL_DRILL_PIPE_INV

This table is used to track the inventory of pipe and tubulars that are ***not*** in the wellbore. (Lists of pipe and tubulars that are installed in the well bore are tracked in the WELL_TUBULAR table.) Inventories are taken on a periodic reporting basis, such as once per shift or tour or day; the table links the inventories to their reporting period. Each row in this table should describe a single item or a group of items with the same characteristics.

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WELL_DRILL_ASSEMBLY

A drilling assembly (or bottom-hole assembly), is the lower portion of a drillstring. This table identifies well drilling assemblies used on a rig for any period of time. Each new assembly is assigned an ASSEMBLY_ID, and is represented by a row in this table – the length and weight of the assembly can be recorded.

Descriptions of individual assembly components (excluding drill bits) are recorded in the WELL_DRILL_ASSEMBLY_COMP table.

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WELL_DRILL_ASSEMBLY_COMP

Use this table to keep track of the component parts, excluding the drill bits, of a well drilling assembly. Use the WELL_DRILL_BIT_% tables to track the drill bits.

Primary keys are UWI, ASSEMBLY_ID, and COMPONENT_ID. Other columns in this table allow for storage of a detailed description of the component.

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WELL_DRILL_ASSEMBLY_PER

This table links a well drilling assembly used on a rig to part of a reporting period or tour, or to more than one period. PERIOD_ID and ASSEMBLY_ID are both in the primary key; columns recording START_TIME and END_TIME are also in the table.

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WELL_DRILL_SHAKER

WELL DRILL SHAKER: The primary and probably most important device on the rig for removing drilled solids from the mud. This vibrating sieve is simple in concept, but a bit more complicated to use efficiently. A wire-cloth screen vibrates while the drilling fluid flows on top of it. The liquid phase of the mud and solids smaller than the wire mesh pass through the screen, while larger solids are retained on the screen and eventually fall off the back of the device and are discarded. Obviously, smaller openings in the screen clean more solids from the whole mud, but there is a corresponding decrease in flow rate per unit area of wire cloth. Hence, the drilling crew should seek to run the screens (as the wire cloth is called), as fine as possible, without dumping whole mud off the back of the shaker. Where it was once common for drilling rigs to have only one or two shale shakers, modern high-efficiency rigs are often fitted with four or more shakers, thus giving more area of wire cloth to use, and giving the crew the flexibility to run increasingly fine screens. (Schlumberger Oilfield Glossary).

This table identifies the screens, and screen positions used in a shaker during a particular drilling period. PERIOD_ID, SHAKER_ID, and SCREEN_OBS_NO are part of the primary key; columns describing sieve mesh size and screen location are also included in this table.

This table is associated with the reference table R_SCREEN_LOCATION, which should be populated first.

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WELL_SIEVE_SCREEN

A sieve is used to separate soil or sedimentary material by particle size: it is usually made of brass, with a wire-mesh cloth (screen) spread across the base. The screen has regularly spaced holes – screens with larger or smaller meshes are used to filter out particles of different sizes.

The WELL_SIEVE_SCREEN table serves to link sieve characteristics (listed in the WELL_SHAKER table) to the analysis of the particles found in sieves (recorded in WELL_SIEVE_ANALYSIS).

The primary key includes the SIEVE_SCREEN_OBS_NO (recorded in the WELL_SHAKER table) and the ANALYSIS_OBS_NO (recorded in the WELL_SIEVE_ANALYSIS table). A column tracks the

SCREEN_MESH_SIZE, while another tracks the number of particles found in a sieve (PARTICLE_HELD_COUNT).

Back to the list of table names

WELL_SIEVE_ANALYSIS

A sieve analysis determines the particle-size distribution in soil, sediment, or rock by measuring the percentage of the particles that pass through standard sieves of various sizes. Rows in this table identify the specific location in a wellbore where sieve analysis samples were obtained. An ANALYSIS_OBS_NO is part of the primary key.

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CAT_EQUIPMENT

Use this table and its children to list and describe the kinds of equipment that you might need. Think of this table as a catalogue or brochure that shows all the kinds of equipment that you may use, but may or may not actually have. Actual pieces of equipment that exist are defined in the table EQUIPMENT.

The column CAT_EQUIP_GROUP can be used to categorize the equipment into broad functional groups such as drilling rigs, or measuring equipment, while the column CAT_EQUIP_TYPE has more specific classifications such as drilling assemblies or pumps.

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CAT_EQUIP_SPEC

This table is used to capture the published specifications for kinds of equipment, such as lengths, diameters, weights and so on. The SPEC_ID column identifies the particular specification being recorded, while the SPEC_TYPE classifies the specification. The REFERENCE_VALUE_TYPE columns record details concerning where a specific measurement was made. (ex: height of strappings on a tank).

The AVERAGE_VALUE, MIN_VALUE, and MAX_VALUE columns contain details about the specifications, while a COST column allows for operating costs to be recorded.

Back to the list of table names

CAT_EQUIP_ALIAS

Equipment that is listed in catalogues may have more than one name, particularly if it is distributed by more than one vendor. This table allows for links to be made between different names. Care should be taken to ensure that these listings actually link the same equipment, rather than similar equipment. The preferred name for the equipment will be stored in CATALOGUE_EQUIP_ID, while aliases can be stored in CAT_EQUIP_ALIAS_ID. Other information about an alias, including its full name, codes, and the name of the company (or other business associate) that uses the alias, can be stored in the table.

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Well Drill Bits

Drill bit data are generated and tracked during drilling operations. Information about the bits in use during each tour is recorded—the type of bit, its size and condition, the intervals it drills, penetration rates, forces and torques on the bit, and size and type of jet. Data recorded in these tables can be linked both to the intervals drilled and to the periods of time in which the drill bits were operating. This information can be interpreted so as to give insight concerning the formations through which the well is drilled. Downtime (and its reason) is recorded, as necessary for financial and payroll purposes.

NOTE: Until PPDM3.8, information concerning drill bits was kept in a single table**.**

WELL_DRILL_BIT_INTERVAL

This table links information about a drill bit to the depth interval in which it was used. It provides a summary of the physical characteristics and of the operating conditions of the drill bit.

All measurements in this table relate to the entire interval for which the drill bit was in the well.

The primary key for this table includes UWI, SOURCE, and BIT_INTERVAL_OBS_NO.

The interval over which the drill bit operated is recorded in the RUN_IN_DEPTH and RUN_OUT_DEPTH tables.

The TOTAL_BIT_REVOLUTIONS can be stored. The BIT_DRILLED_RATE records the rotation rate of the drill bit, while the AVG_PENETRATION_RATE, MAX_PENETRATION_RATE and MIN_PENETRATION_RATE columns measure the distance drilled per unit of time. The

AVG_PENETRATION_RATE can be calculated from other data recorded in the table – the DISTANCE_DRILLED and the BIT_OPERATING_TIME.

The BIT_NUMBER and EQUIPMENT_ID are assigned to identify the particular drill bit in use -- descriptive information about the bit and its jets can be stored in BIT_JET_COUNT, BIT_SIZE_%, DRILL_BIT_TYPE, and REPORTED_TFA (total fluid area).

Condition of the cutting structure and of the bit can be recorded in the CUTTING_STRUCTURE_% columns and the GAGE_OUT_DISTANCE tables.

Other measurements that are recorded in the table include the TORQUE, FLOW_RATE (measures the amount of drilling fluid passing through the bit), and MIN_FORCE_ON_BIT and MAX_FORCE_ON_BIT (the weight, or force, of the drill string that is loaded on the bit).

Back to the list of table names

WELL_DRILL_INT_DETAIL

Use the WELL DRILL BIT INTERVAL DETAIL to capture details about drill bit operation over a particular depth interval that are not recorded in the WELL_DRILL_BIT_INTERVAL table. Any type of measured information is supportable.

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WELL_DRILL_BIT_PERIOD

This table may be used to describe characteristics pertaining to drill bit use during a specified reporting period. Metrics that are stored are used to calculate statistics and to satisfy regulatory reporting.

Both the PERIOD_ID and the BIT_INTERVAL_OBS_NO are part of the primary key -- ***all measurements recorded in this table relate to a particular drilling period.***

The actual operating time for the bit within the drilling period can be stored in the TOTAL_PERIOD_RUN column.

The AVG_FORCE_ON_BIT, MAX_FORCE_ON_BIT, and MIN_FORCE_ON_BIT record the weight, or force, of the drill string that is loaded on the bit over the drilling period.

The TOTAL_BIT_REVOLUTION, AVG_ROTARY_RPM, MAX_ROTARY_RPM and MIN_ROTARY_RPM, TORQUE and TORQUE measured over the drilling period are also recorded.

The distances drilled within the drilling period can be recorded in the TOP_DEPTH, BASE_DEPTH, and TOTAL_DRILLED_DIST columns.

The flow rate of the drilling fluid through the bit can be recorded in the FLOW_RATE column.

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WELL_DRILL_BIT_JET

This table is used to describe each jet on a drill bit. In some cases, more than one kind of jet may be used on a drill bit.

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WELL_DRILL_BIT_CONDITION

The table is used to track the condition of the well drill bit as it is evaluated over time. Each condition recorded is linked to a BIT_INTERVAL_OBS_NO, and so the progression of a drill bit's condition can be followed.

This information can be used to determine performance statistics for bit types, to ensure that maintenance is conducted as efficiently as possible, and to determine which kinds of bits to use in the future.

Back to the list of table names

WELL_AIR_DRILL_PERIOD

This table may be used to link an air drilling interval to one or more drilling periods. Included in the primary key are a DEPTH_OBS_NO (assigned to identify a depth interval), a PERIOD_ID (assigned to identify a particular time period), and an AIR_DRILL_OBS_NO (assigned to all air drilling records).

Other information stored in this table include the TOP_DEPTH and BASE_DEPTH for the interval drilled.

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Well Drill Horizontal

This grouping contains tables that record data specifically related to directionally drilled wells. A single wellbore can be deviated; alternatively, many directional holes can branch off from a wellbore. The point at which either deviation from the vertical, or branching takes place is the kickoff point; the part of the wellbore drilled starting from the kickoff point is known as a lateral hole. In turn, lateral holes may also branch – these branches are known as spokes. In directional

wells, the measured depth will be greater than both the true vertical depth and the horizontal displacement.

Because the wellbore is angled, the hole well often has a longer contact with a producing formation than would a vertically drilled hole. Data concerning these contacts are recorded.

In the case where multiple holes branch off from a wellbore, the table WELL_XREF should be used to wshow the relationships between holes.

WELL_HORIZ_DRILL

This table contains information about horizontally drilled wells. The type of well as determined by its radius of curvature (Ultra Short, Short, Medium and Long) is recorded in BUILDUP_RADIUS_TYPE. Further details about the curvature are given in the BUILDUP_RATE_% columns. The maximum angle of deviation (the drift angle) is stored in the MAX_DEVIATION_ANGLE column.

Total HORIZONTAL_DISPLACEMENT of the well is tracked, as is the length within the targeted formation (WB_LENGTH_IN_FORMATION) **???????** and within the payzone (PAY_LENGTH).

The targeted formation is identified in HORIZ_STRAT_UNIT_ID (STRAT_NAME_SET_ID must also be entered), and the RESERVOIR is also identified.

The reason for, and type of horizontal drilling are recorded in HORIZ_DRILLING_REASON and HORIZ_DRILLING_TYPE. The CONTRACTOR can be reported, and information about the rat holes can be stored in the RAT_HOLE_% columns.

Any lateral hole that is drilled is assigned a LATERAL_HOLE_ID; the LATERAL_HOLE_LENGTH is also recorded.

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WELL_HORIZ_DRILL_KOP

This table contains information related to kickoff points. A kickoff point is the point where the well bore begins to deviate from vertical to horizontal or that point where a spoke begins.

Each kickoff point is assigned a KICKOFF_POINT_OBS_NO (part of the primary key). The measured and true vertical depths of the kickoff point can be recorded in the columns KICKOFF_POINT_MD and KICKOFF_POINT_TVD. A LATERAL_HOLE_ID can be assigned, and any position in the well can be given a NODE_ID.

Back to the list of table names

WELL_HORIZ_DRILL_SPOKE

Use this table to record information related to a spoke and its terminus (the end point of a spoke).

The KICKOFF_POINT_OBS_NO and SPOKE_OBS_NO are primary keys in this table; data recorded in these columns, along with the UWI and LATERAL_HOLE_ID, identify the spoke.

In the SPOKE_LENGTH column, the distance along the spoke (from kickoff point to terminus) is recorded. The SPOKE_MD and SPOKE_TVD columns record the measured and true vertical depths from the surface to the spoke terminus.

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WELL_HORIZ_DRILL_POE

The Horizontal Drilling Point of Entry table contains information related to point of entry, the point where the horizontal wellbore penetrates the targeted formation or reservoir. A POINT_OF_ENTRY_OBS_NO is part of the primary key, and the LATERAL_HOLE_ID can also be identified. The POINT_OF_ENTRY_MD and POINT_OF_ENTRY _TVD columns record the measured and true vertical depths from the surface to the point of entry.

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Well Drill Fluids and Additives & Well Mud

Drilling fluids (well mud) cool and lubricate drill bits, carry cuttings to the surface, and stabilize the hydrostatic pressure of the system by preventing the entry of fluids and gases into the wellbore. They can be composed of liquids, gases, or mixtures of liquids, gases, and solids. Additives are added to mud in order alter properties such as weight (density) and viscosity.

Interpretation of drilling fluid data can lead to information used in many different areas of an E&P operation.

- Mud weight (density) and the amount of mud used give information about fluid pressure in the wellbore.
- Mud can physically stabilize formations, but its components can also alter them—swelling clays can plug pores and reduce permeability, and chemical reactions with formation materials can occur.
- Muds are regulated for environmental purposes, and information concerning mud composition is important in site reclamation
- Mud properties can affect wireline logs
- Suppliers of mud, and costs related to drilling fluids, are tracked by billing departments.

Tables in the Well Drilling Fluids and Additives grouping link well mud – its use, additives, and inventories – to specific drilling periods and to specific intervals drilled.

The CAT_ADDITIVE _% group of tables gives details about ordering information, as well as specific information about the composition of mud additives.

The WELL_MUD_% tables allow the chemical, physical, and electrical properties of mud used during certain time periods to be tracked.

WELL_DRILL_MUD_ADDITIVE

This table is used to capture a list of all the additives in the well mud used during a reporting period or tour of operations. Primary keys include UWI, DRILL_PERIOD_ID, ADDITIVE_ID, and ADDITIVE_SEQ_NO.

The ADDITIVE_METHOD and ADDITIVE_PERIOD store information about the process of adding an additive to the mud.

The amount of additive added to the drilling fluid during the drilling period can be listed in two ways. The QUANTITY_VALUE_% columns list specific amounts of additives, with standard units of measure. The QUANTITY_COUNT column list amounts in non-standard terms (ex. sacks, buckets). In order to convert counts to standardized units, the number in the QUANTITY_COUNT column can be multiplied by the corresponding measure in the CAT_ADDITIVE..PURCHASE_QUANTITY columns. See the example in the "Sample Queries" section of this guide.

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WELL_DRILL_ADD_INV

This table is used to record the inventoried amounts of each additive available at the wellsite at a specified time (often the beginning of a well tour).

QUANTITY_VALUE_% columns list specific amounts of additives, with standard units of measure. QUANTITY_COUNT _% columns list amounts in non-standard terms (ex. sacks, buckets). In order to convert counts to standardized units, the number in the QUANTITY_COUNT column can be multiplied by the corresponding measure in the CAT_ADDITIVE..PURCHASE_QUANTITY column. See the example in the "Sample Queries" section of this guide.

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CAT_ADDITIVE

Think of this table as a catalogue of all the kinds of additives that can be purchased or created. Details about an additive (its operational use, function, and common name are given) are recorded in the ADDITIVE_GROUP, ADDITIVE_TYPE, and ADDITIVE_NAME columns. Purchasing data,

including information about the manufacturer, the packaging, and the quantity per package can also be stored.

ADDITIVES can be tracked by their CATALOGUE_ADDITIVE_ID, the primary key for this table.

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CAT_ADDITIVE_TYPE

This table links the type, or function, of an additive (for example, weighting agent, viscosifier, lubricant) to its operational use (for example, well drill mud additive, treatment additive, processing additive). Note that the function of this table may also be assumed by the CLASSIFICATION module for more robust and complete classifications.

Back to the list of table names

CAT_ADDITIVE_SPEC

Use the CATALOGUE ADDITIVE SPECIFICATIONS table to record known properties of the additives. The CATALOGUE_ADDITIVE_ID is included in the primary key.

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CAT_ADDITIVE_ALIAS

Chemically and physically identical additives may have more than one name, code or identifier, particularly if they are distributed by more than one vendor. This table links identical products. Care should be taken to ensure that these listings describe the same product, rather than similar products. All possible names, codes and other identifiers can be stored here.

Use the CAT_ADDITIVE_ALIAS table to link identical additives; use the CAT_ADDITIVE_XREF table to link non-identical, but similar products.

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CAT_ADDITIVE_XREF

Use this table to list relationships between additives. For example, the table can link a new additive to the older two products that it has replaced.

Use the CAT_ADDITIVE_ALIAS table to link identical additives; use the CAT_ADDITIVE_XREF table to link non-identical, but similar products.

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WELL_MUD_SAMPLE

A mud sample is a sample of the fluid that is circulated through the wellbore during the drilling operation. Mud's physical properties have a direct effect on the measurements taken during a logging operation, thus this table contains information on the physical, as well as chemical and electrical properties of the drilling fluid associated with a set of wireline logs from a wireline logging job.

The table links properties of the mud samples (including MUD_DENSITY, MUD_PH, MUD_VISCOSITY) to well and circulation data (including SAMPLE_DEPTH, FLUID_FLOW) and to information pertaining to wireline logs (including the measures of time between the stopping of the circulation system and the starting of the wireline logging).

The primary key includes a SAMPLE_ID, which is assigned to each sample taken.

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WELL_MUD_RESISTIVITY

This table contains information pertaining to the electrical resistivity found in mud, mud cake, or filtrate. Resistivity can be used to determine the nature of the strata penetrated (i.e., the content of gas, oil, or water enclosed in rock pores). Formations containing salt water have low resistivity, while those containing freshwater or oil have higher resistivities. As resistivity changes with temperature, temperature information can be stored in this table.

The SAMPLE_ID, as well as a RESISTIVITY_OBS_NO are part of the primary key.

Back to the list of table names

WELL_MUD_PROPERTY

This table allows chemical and physical properties associated with a mud sample to be recorded. Properties may be quantitative or qualitative. Primary keys in this table are UWI, SOURCE, SAMPLE_ID, and PROPERTY_OBS_NO.

The reference table R_MUD_PROPERTY_TYPE, should be populated before this table. If codes are used to in property descriptions, the reference table R_MUD_PROPERTY_CODE, should be populated beforehand.

Back to the list of table names

Well Directional Survey

The wellbore path is monitored by performing directional surveys, either by tracking discrete points within the well, or through measurements taken while drilling (MWD). The position of the wellbore may be surveyed by a downhole device, mounted in the drill string or operated on a wireline. The data may be recorded and held within the device, or transmitted in real time to the surface. The simplest survey device records only the inclination of the wellbore at selected depths. More advanced devices allow for accurate three-dimensional mapping of the entire well.

Directional survey information is captured in the PPDM model in three related tables, recording:

- general information: type of tool, dates and depth range, computation method, coordinate system
- survey stations: measured and recalculated *xyz* position, and related data.
- geometry: a table specifically for spatially enabling the PPDM.

WELL_DIR_SRVY

This table contains header information about directional surveys which have been performed on a wellbore. A downhole survey charts inclination (the degree of departure of the wellbore from vertical) and the azimuth (the direction of departure, measured clockwise from North). Many directional surveys can be conducted on a wellbore.

The table captures general information and other data that apply to all points in the wellbore survey. Numerous foreign keys allow for definition of various parameters necessary to convert the raw survey data into correct positional information.

The SURVEY_ID column identifies a specific run in the wellbore by the survey device, and is part of the primary key in this table. When a wellbore is surveyed by a wireline device, several successive surveys may be required for the complete path. In some cases, a well is resurveyed with a similar or different type of device. This can result in more than one survey for the same depth interval.

The DIR_SURVEY_CLASS column describes a general classification based on the type of survey data collected. The common classes, defined in the reference table, R_DIR_SRVY_CLASS, yield either inclination data, or inclination and azimuth data.

The SURVEY_TYPE column records the classification of the survey based on the method and device. These types, defined in reference table, R_DIR_SRVY_TYPE, include wireline gyroscope, multi-shot, and MWD (measurements-while-drilling).

The SOURCE_DOCUMENT column captures the type of document that the survey data were obtained from. This information may be helpful in assessing the quality of the data. Use this in conjunction with the WELL_DIR_SRVY.SOURCE column.

The COORD_SYSTEM_ID column is one of several columns used to capture information on the positional framework of the survey, essential for computing the correct X and Y values.

TOP_DEPTH and BASE_DEPTH define the surveyed interval. If more than one survey exists, there may be gaps or overlaps in coverage of the wellbore. Choices and decisions are left to the users of the survey data.

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WELL_DIR_SRVY_STATION

The WELL DIRECTIONAL SURVEY STATION table records data about the individual directional survey points located along the wellbore during a downhole survey. For each survey (SURVEY_ID primary key), there may be multiple rows of data, once corresponding to each measured depth point, or station. Measurements at a survey point include the measured depth of the station (STATION_MD), the inclination from the vertical axis that the wellbore trends (INCLINATION) , and the clockwise departure of the survey point from the north reference (AZIMUTH). The azimuth may not be included if a simple survey was conducted.

Most other columns in this table are for parameters (e.g., VERTICAL_SECTION) and computed results (e.g., LATITUDE, X_OFFSET).

A unique STATION_ID may be provided by the survey operator or data supplier.

LATITUDE and LONGITUDE are computed values. In order to have meaningful data, every station within a wellbore must have its latitude and longitude calculated with reference to the same coordinate system. Therefore, the WELL_DIR_SRVY.COORD_SYSTEM_ID column must be populated if latitude and longitude are captured. (The model does not enforce population because some business requirements (e.g., for an inclination-only survey) do not include coordinate position.)

Back to the list of table names

WELL_DIR_SURVEY_GEOMETRY

This table provides a method for spatially enabling well directional survey descriptions through association with appropriate geometries in a spatial engine such as SDE.

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Well Services

Services, such as those provided by drilling contractors and well loggers, can be traced during the drilling period. Related closely to the Business Associates module, these tables include fields for describing the services, the quality of service, and metrics pertaining to the services.

WELL_BA_SERVICE

Use the WELL BUSINESS ASSOCIATE SERVICE table to keep track of services that are performed on the well by business associates. The services tracked here may include various types of technical services that are not explicitly managed in other existing parts of the model, including services performed on the production string, and services required for completions.

Back to the list of table names

WELL_DRILL_PERIOD_SERV

This table links services described in WELL_BA_SERVICE table to the drilling periods in which the service was provided. Metrics related to the service may be defined and stored in this table as needed.

Back to the list of table names

Well Components

WELL_COMPONENT

This table is used to capture the relationships between wells and business objects such as equipment, documents, seismic sets, and contracts.

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Implementation Considerations

Constraints in PPDM

It is essential that anyone who is considering using PPDM version 3.8 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 3.8 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 3.8.

- 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, Business Associates, Records Management, Support Facilities, Production Entities and Land Rights.

However, as some tables in the Well Operations Module refer to data in these other modules, some check constraints are present. The tables WELL_COMPONENT, WELL_ACTIVITY_COMPONENT, WELL_DRILL_ADDITIVE_INV, and WELL_DRILL_PERIOD_VESSEL all have primary keys ending in ending in _TYPE, where values entered are constrained by data located elsewhere.

Identifying Referential Tables in PPDM3.8

Many tables in PPDM38A2 have primary key and foreign key constraints for some of their columns. These constraints can be traced in the PPDM_CONS-COLUMN TABLE.

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	FEET
JONES44	1560	METERS
12345	1400	FEET

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 3.6 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 PPDM 3.8

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.

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)

Subject

Question?

Answer

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.

- **Spatial or GIS queries:** Spatial queries are not thoroughly addressed in this section of the reference guide; how you deal with these queries depends on the spatial engine you are using. In many cases, we have avoided using spatial queries because the number of query lines needed obscures the rest of the query and makes it more difficult to read. Sometimes, we have provided a connection to a NAMED AREA, rather than a lat/long box.

- **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.

- **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.

Seismic Brokerage and Ownership

Tracking Wells

How many abandoned wells do I have in field XYZ. What are their TVDs and oldest formations? Do I have any cuttings from these wells?

```
SELECT   W.UWI, W.ASSIGNED_FIELD, WS.STATUS, MAX_TVD, MAX_TVD_OUOM,
W.OLDEST_STRAT_UNIT_ID, WSH.SAMPLE_TYPE, WSH.SHOW_TYPE
FROM     WELL W, WELL_STATUS WS, WELL_SHOW WSH
WHERE    WSH.UWI=W.UWI AND W.UWI=WS.UWI
   AND   W.ASSIGNED_FIELD = 'XYZ'
AND            (WS.STATUS = 'ABD OIL' OR WS.STATUS = 'ABD GAS')
```

Tracking Drill Mud Additives

Has drilling fluid additive abc been used in any of my drilling operations in province XYZ since 2006. If so, when was it used, and how much was used?

```
SELECT   W.UWI, W.PROVINCE_STATE, WDMA.ADDITIVE_ID,
WDMA.DRILL_PERIOD_ID, WDMA.ADDITIVE_PERIOD,
WDMA.ADDITIVE_PERIOD_UOM, WDMA.QUANTITY_COUNT, CA.PURCHASE_QUANTITY,
CA.PURCHASE_QUANTITY_TYPE, CA.PURCHASE_QUANTITY_UOM,
WDMA.QUANTITY_VALUE, WDMA.QUANTITY_VALUE_UOM
FROM     WELL W, WELL_DRILL_MUD_ADDITIVE WDMA, CAT_ADDITIVE CA
WHERE    W.UWI=WDMA.UWI
  AND          W.PROVINCE_STATE = 'XYZ'
  AND    WDMA.ADDITIVE_ID =abc'
```

Tracking Equipment

Pump ETS P-1 failed in drill_period 19990115-1, well UWI 00052404610W400. During each tour at that well, what was the maximum pressure it reached? What was its average strokes/min.? Order by the well tour.

```
SELECT   WDPE.UWI, WDPE.PERIOD_ID, WDPE.EQUIPMENT_ID,
WDPE.AVG_PUMP_PRESSURE, WDPE.AVG_PUMP_PRESSURE_OUOM,
WDPE.PUMP_STROKE, WDPE.PUMP_STROKE_OUOM
FROM     WELL_DRILL_PERIOD_EQUIP WDPE
WHERE    EQUIPMENT_ID = 'ETS P-1'
   AND   UWI = '00052404610W400'
ORDER BY       WDPE.PERIOD_ID
```

Pump ETS P-1 failed in drill_period 19990115-1, well UWI 00052404610W400. When was it purchased? When was it commissioned? What is its serial number? What maintenance has it had? Was any of this maintenance a result of a previous failure?

```
SELECT   E.EQUIPMENT_ID, E.PURCHASE_DATE, E.COMMISSION_DATE,
E.SERIAL_NUM, EM.MAINT_TYPE, EM.SCHEDULED_DATE, EM.FAILURE_IND
FROM     EQUIPMENT E, EQUIPMENT_MAINTENANCE EM
WHERE          E.EQUIPMENT_ID = EM.EQUIPMENT_ID
AND                 E.EQUIPMENT_ID= 'ETS P-1'
```

Pump ETS P-1 failed in drill_period 19990115-1, well UWI 00052404610W400. How many hours had it been operational? List the pump name, the UWIs and Drill periods it has worked, the amount of time per drill period, the total time worked. Order by drill period.

```
SELECT   EQUIPMENT_ID, UWI, PERIOD_ID, BOOKED_TIME, P.DEFAULT_UOM_ID
UNITS, SUM(BOOKED_TIME) OVER (ORDER BY PERIOD_ID) TOTALTIME,
P.DEFAULT_UOM_ID UNITS
FROM     WELL_DRILL_PERIOD_EQUIP, PPDM_COLUMN P

WHERE    EQUIPMENT_ID = 'ETS P-1'
AND      P.TABLE_NAME = 'WELL_DRILL_PERIOD_EQUIP'
AND      P.COLUMN_NAME='BOOKED_TIME'

ORDER BY       PERIOD_ID
```

Tracking Crews

How do I track the hours a crew spends on each activity (in this case, crew #1) ? I'd like to see the UWI of the wells they worked on, the period IDs for their shifts, the date, start and end times of the particular activity, the duration of each activity, and a cumulative total of the time per activity. I'd like the list sorted by activity, and then by date.

```
SELECT  WA.EVENT_DATE, RN.UWI, RN.PERIOD_ID, WA.ACTIVITY_TYPE,
WA.START_TIME, WA.END_TIME, WA.REPORTED_ELAPSED_TIME,
SUM(WA.REPORTED_ELAPSED_TIME) OVER (PARTITION BY WA.ACTIVITY_TYPE
ORDER BY WA.EVENT_DATE, RN.PERIOD_ID, WA.START_TIME) CUMULATIVETOTAL
FROM WELL_ACTIVITY WA,
(SELECT DISTINCT WDPC.CREW_REFERENCE_NUM, WDPC.PERIOD_ID, WDPC.UWI
FROM WELL_DRILL_PERIOD_CREW WDPC
WHERE WDPC.CREW_REFERENCE_NUM= '1') RN

the subquery above finds the PERIOD_IDs AND UWIs in which crew 1
worked; this subset of data is given the label RN, and is queried by
the containing statement.

WHERE WA.UWI=RN.UWI
AND WA.PERIOD_ID = RN.PERIOD_ID
ORDER BY WA.ACTIVITY_TYPE
```

When drilling certain wells for my company, a drilling crew is required to perform a number of inspections, listed as the inspections with the CHECK_SET_ID 'ETS HCO030' in the WELL_DRILL_CHECK_SET table. How do I track the safety inspections that a crew hasn't completed? The report should list the well name, the period ID, the missing inspections, and the crew working in that period.

```
SELECT DISTINCT WDC.UWI, WDC.PERIOD_ID, WDC.CHECK_TYPE,
WDCT.DESCRIPTION NOT_INSPECTED, WDPC.CREW_REFERENCE_NUM
```

```
FROM WELL_DRILL_CHECK WDC, WELL_DRILL_CHECK_TYPE WDCT,
WELL_DRILL_PERIOD_CREW WDPC
WHERE WDC.UWI=WDPC.UWI AND WDC.PERIOD_ID=WDPC.PERIOD_ID AND
WDCT.CHECK_TYPE=WDC.CHECK_TYPE AND
WDCT.CHECK_SET_ID=WDC.CHECK_SET_ID
AND WDC.CHECK_TYPE = (
(SELECT WDCT.CHECK_TYPE
FROM WELL_DRILL_CHECK_TYPE WDCT
WHERE WDCT.CHECK_SET_ID='ETS HCO030')

MINUS
(SELECT WDC.CHECK_TYPE
FROM WELL_DRILL_CHECK WDC
WHERE WDC.CHECK_SET_ID='ETS HCO030')
          )
```

Does well XYZ have any spokes? If so, how many, which reservoirs do they reach?

```
SELECT DISTINCT WDC.UWI, WDC.PERIOD_ID, WDC.CHECK_TYPE,
WDCT.DESCRIPTION NOT_INSPECTED, WDPC.CREW_REFERENCE_NUM
FROM WELL_DRILL_CHECK

SELECT WHD.UWI, WHD.
FROM WELL_HORIZ_DRILL WHD
WELL_HORIZ_DRILL_KOP KOP
WELL_HORIZ_DRILL_POE POE
WELL_HORIZ_DRILL_SPOKE SPOKE
```

Appendix B: Changes to the Model

The PPDM Association has made a concerted effort to reduce the impact of new model development on members who are using other versions of PPDM. However, any new development is accompanied by some changes. Arriving at a model that is sufficiently detailed to meet the business needs of every member and yet flexible or abstract enough to be shielded from corporate or regulatory variations is complex, but achievable. Every attempt is made to ensure the model complies with, but is relatively independent of, specific jurisdictional requirements, changes in government policy, regulations or structure that may at times invalidate portions of the model. Internal re-engineering of business processes in industry companies may affect business requirements, which drive the data model. Rapid technological changes may also affect the model structure.

This section identifies all applicable changes from the latest version to the newest release version, to help members implement the latest version of the PPDM model.

Changes Prior To Version 3.5

The WELL table was the first table designed in PPDM, in about **(?????)** 1989. It has undergone changes over time, but still retains some of the original requirements. These original requirements may be important in supporting older implementations, although there may be newer developments. For example, as database systems have evolved, the need to denormalize for query performance has diminished, and so some columns in this table are best left unpopulated if the data can be efficiently retrieved from the primary table. Any attempt to store the same information in more than one table is an invitation to quality problems and complicates data loading procedures.

Changes Between Versions 3.7 and 3.8

The Well Operations Module was re-designed for version 3.8. Therefore, numerous tables have been added and deleted, and within tables remaining from version 3.7, columns have also been added. Additionally, the Well Horizontal Drilling Module from 3.7 was merged into the Well Operations Module.

The following lists detail the deletion, renaming, and addition of tables to the Well Module. For complete documentation and a mapping between versions, please refer to the model mapping, available from the PPDM Association.

Deleted Tables

WELL_EVENT

WELL_TOUR_OCCURRENCE

WELL-DRILL_BIT

WELL_DRILL_STATUS

Renamed Tables

3.7 Table	***3.8 Table***
WELL_DRILL_MEDIA_INTRVL	WELL_DRILL_MUD_INTRVL
WELL_DRILL_MEDIA_WEIGHT	WELL_DRILL_MUD_WEIGHT

New Tables

CAT_ADDITIVE

CAT_ADDITIVE_ALIAS

CAT_ADDITIVE_SPEC

CAT_ADDITIVE_TYPE

CAT_ADDITIVE_XREF

WELL_ACTIVITY

WELL_ACTIVITY_COMPONENT

WELL_ACTIVITY_SET

WELL_ACTIVITY_TYPE

WELL_ACTIVITY_TYPE_ALIAS

WELL_ACTIVITY_TYPE_EQUIV

WELL_AIR_DRILL_PERIOD

WELL_COMPONENT

WELL_DRILL_ADD_INV

WELL_DRILL_ASSEMBLY

WELL_DRILL_ASSEMBLY_COMP

WELL_DRILL_ASSEMBLY_PER

WELL_DRILL_BIT_CONDITION

WELL_DRILL_BIT_INTERVAL

WELL_DRILL_BIT_JET

WELL_DRILL_BIT_PERIOD

WELL_DRILL_CHECK

WELL_DRILL_CHECK_SET

WELL_DRILL_CHECK_TYPE

WELL_DRILL_EQUIPMENT

WELL_DRILL_INT_DETAIL

WELL_DRILL_MUD_ADDITIVE

WELL_DRILL_PERIOD

WELL_DRILL_PERIOD_CREW

WELL_DRILL_PERIOD_EQUIP

WELL_DRILL_PERIOD_INV

WELL_DRILL_PERIOD_SERV

WELL_DRILL_PERIOD_VESSEL

WELL_DRILL_PIPE_INV

WELL_DRILL_REMARK

WELL_DRILL_REPORT

WELL_DRILL_SHAKER

WELL_DRILL_STATISTIC

WELL_DRILL_WEATHER

WELL_MUD_PROPERTY